

Feasibility of Using Interstate Highway Right-of-Way to Obtain a More Survivable Fiber-Optics Network

Ronald W. Hess, Bridger M. Mitchell,
Eleanor C. River, Don H. Jones, Barry M. Wolf

40 Years
1948-1988

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January 1988

Prepared for
The U.S. Department of Transportation
The National Communications System

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PREFACE

This report documents an analysis of the legal, institutional, and economic feasibility of a possible solution for hardening¹ the nation's emerging fiber-optics communications "backbone" at no out-of-pocket cost to the government. The proposed solution would exchange access to Interstate highway right-of-way, which telecommunications companies are currently prohibited from using but which is quite attractive to them from the perspective of installation cost savings, for the hardening of fiber-optics systems using such right-of-way.

The study was sponsored jointly by the U.S. Department of Transportation (DOT) and the National Communications System (NCS). It is the stated intent of these government entities to use the information contained herein, along with other technical and policy information, to reach conclusions regarding appropriate government policy with respect to the proposed exchange concept. However, neither DOT nor NCS necessarily endorses all the conclusions of this report.

The work was carried out in RAND's National Defense Research Institute, an OSD-supported Federally Funded Research and Development Center.

¹Against the physical and electronic threats associated with nuclear explosions.

SUMMARY

Among its responsibilities, the Office of the Manager, National Communications System (NCS), is charged with the restoration and reconstitution of domestic telecommunications services in *all* emergency situations. By far the most overwhelming emergency situation for which the NCS must prepare, and the one addressed in this study, is the aftermath of a nuclear war. Devastation will be widespread. Large segments of the national telecommunications network will have been destroyed. It is assumed, however, that there will be surviving pockets of population that will be seeking information about medical services and food and attempting to assess the extent of the damage. Realistically, "reconstitution" of the telecommunications infrastructure in such an environment will take the form of improvising with whatever is left—from two-way radios to surviving segments of the public switched network. There are, however, a number of measures that could be undertaken in advance to facilitate such reconstitution. One such measure is to develop a hardened "backbone" network—a network constructed so that it is more likely to survive the effects of a nuclear war than the typical commercial installation—with perhaps two east-west legs and three north-south legs crisscrossing the continental United States.

Recently, the NCS has proposed a concept for obtaining a hardened backbone, using fiber-optics technology, at no out-of-pocket cost to the government. This proposal would exchange access to Interstate highway right-of-way (ROW), which telecommunications companies are currently prohibited from using¹ but which is quite attractive to them from the perspective of installation cost savings, for the hardening of fiber-optics systems using such ROWs.² Consequently, the goal

¹Current Federal Highway Administration (FHWA) policy prohibits longitudinal use of Interstate ROW by utilities except when unusual or exceptional economic or environmental hardship can be demonstrated (see Code of Federal Regulations, Title 23, Part 645, Subpart B).

²Conceptually, other types of public highways (i.e., major arterials other than Interstates) are also potential candidates for hardened fiber-optics routes. However, for a variety of reasons, the *long-haul* carriers do not find non-Interstate highways to be a particularly attractive option (relatively high initial installation cost and uncertainty with respect to responsibility for relocation and damage). Moreover, since there are not currently any blanket prohibitions on utility use of non-Interstate highway ROW, the federal government has no leverage with which to bargain for enhancements. Consequently, although non-Interstate highways are a useful point of comparison in assessing the economic viability of alternative ROW types, it is the Interstate highways that are properly the focus of this feasibility study.

of this study was to assess the feasibility of the proposed concept. (It was not a goal to assess its desirability since we did not evaluate the concept in the context of other means for facilitating long-haul domestic communications in the post-nuclear attack environment.)

CONCERNS OF HIGHWAY OFFICIALS

Utilities in General

Highway officials have long had serious misgivings with respect to permitting utilities to longitudinally occupy Interstate highway ROW. Foremost among their concerns are the related issues of safety and traffic flow. The Interstate Highway System is the safest of all U.S. road systems. The restriction that no activity is permitted within Interstate ROW unless it directly contributes to the operation of the highway is one of a number of factors that have contributed to this safety record. For this reason, utilities are prohibited. Unfortunately, available statistical data do not permit us to gauge the potential magnitude of the effect utility installations would have on Interstate safety and traffic flow. From a common sense point of view, it seems inevitable that utility installations on Interstate ROW will have a negative effect on the safety and free movement of vehicles. However, depending on the specific circumstances associated with an installation,³ the magnitude of the effect could vary from imperceptible to significant.

Other concerns of highway officials include:

- Relocation costs—If the highway should be widened or otherwise improved, who will pay for moving the utility, the utility company or the state?
- Liability—If a utility is accidentally damaged in the course of road maintenance or improvement, who will be liable for the costs of repairing the break? The loss of revenue? Any consequential damages?
- Additional costs—Utility use of Interstate ROWs would undoubtedly create additional costs for state highway authorities in terms of administering permits, policing installation and maintenance, and resolving downstream conflicts.

³Specific circumstances that can vary from installation to installation are location in ROW (median or fence line); environment (rural or urban); extent of precautionary safety measures employed (e.g., traffic control measures and working hours); and type of utility being installed, which affects the installation rate, obtrusiveness of construction activities, and frequency of maintenance.

Fiber Optics In Particular

When taken in the context of the full spectrum of possible utility installations, these concerns clearly have merit. However, with respect to the specific case of fiber-optics installations, we feel that these concerns have relatively little foundation. Based on reasonably analogous toll-road experience, we see no reason that the relocation and administrative cost issues as well as most liability questions cannot be handled by contractual means. Additionally, it is our opinion that fiber-optics installations in *rural* areas would have minimal effect on Interstate safety and traffic flow.

Yet despite the minimal effects fiber installations are likely to have, highway officials remain opposed to their placement in Interstate ROW. Some have had bad experiences with utilities in the past (i.e., the utilities did not follow agreed-upon installation procedures) and simply do not trust any of them. But it is our opinion that the bulk of the opposition results from the fact that highway officials view fiber optics as a Trojan horse—if fiber is let on, then all utilities will have to be let on and then the safety, traffic flow, and administrative headaches will really start.

The question then becomes one of whether or not access can be limited to fiber optics. As a matter of law, discrimination among utilities for access to a government benefit requires a “rational basis” (Equal Protection Clause of the Constitution). But the methodology by which courts look for such a rational basis is remarkably generous to the government decisionmaker. Generally speaking, so long as fiber-optics utilities have *any* advantage over other utilities with respect to *any* single criterion—or any *combination* of criteria—then a policy that limits access to hardened fiber optics would not be held to violate Equal Protection.

In this regard, we have heard several suggestions on how fiber-optics utilities might be distinguished from other utilities. *National security* is one possibility, although a number of utilities can make claims to their national security necessity including oil and natural gas transmission pipelines and power transmission cables. *Safety* appears to have a firmer foundation. Utilities that transport a volatile or hazardous medium (such as oil and gas pipelines and power transmission cables) might be excluded, as well as utilities which, if ruptured, could undermine the stability of the roadway (water, sewer). Additionally, compared with other utilities, fiber-optics *installation* is relatively fast and unobtrusive and *maintenance* requirements are minimal.

In summary, while we cannot state with absolute certainty what the ultimate outcome of judicial challenges to such distinctions would be,

we nevertheless believe a strong case can be made for limiting access to Interstate ROW to fiber optics.

FEASIBILITY OF BARTER CONCEPT

There are four questions that need to be answered affirmatively if the proposed "access-for-hardening" concept is to result in a hardened fiber-optics backbone:

1. Can complete ROW continuity be obtained for the entire backbone network?
2. Can minimum standards of hardness be imposed as a condition of access? And if so, by whom?
3. Is there really a cost advantage on the Interstates (relative to the next best alternative) sufficient to support the cost of enhancements and the ROW payments asked by the states?
4. And finally, even if all the other conditions are met, will all the backbone routes be financially attractive to the carriers?

Our answers to these questions are summarized below.

Can Backbone ROW Continuity Be Obtained?

We examined three generic approaches by which ROW continuity might be obtained:

- Pursuing *voluntary* federal/state cooperation;
- *Inducing* state cooperation by tying federal highway aid to a state's granting of access; and
- *Compelling* cooperation through the congressional power of eminent domain.

Of the three options, voluntary federal/state cooperation is certainly the most politically attractive. However, we believe that the chances of getting a full backbone network using this approach are very small. This conclusion is based on the strongly negative attitude emerging from a survey of state highway departments and the fairly noncommittal attitude emerging from a survey of state governors. On the other hand, from a practical standpoint, the two remaining options (tie to federal highway aid and condemnation of required easement) are both quite likely to produce the necessary continuity. However, both of these options require congressional approval and we are unable to say at this time what type of political support they might enjoy.

Can the Carriers Be Required to Enhance Systems?

All states have the authority to impose construction standards for projects using state-owned property and therefore have the power to contract for national security/emergency preparedness (NSEP) enhancements. The real difficulty here is not with respect to the states' authority to impose standards but rather persuading *all* states comprising the backbone network to impose a minimum level of hardening as a *quid pro quo* for utility access. Even if all the states along the backbone route grant access (which is highly unlikely) those that do so grudgingly may promote relatively high minimum standards to discourage carrier interest. But there will be other states that will want to maximize revenues or encourage fiber installation and will therefore try to keep NSEP standards as low as possible. Consequently, reaching agreement among the states is likely to be a formidable task.

Because the states own the Interstate rights-of-way, the federal government cannot impose NSEP enhancements on private carriers through any existing legal authority. However, Congress could provide the states a strong incentive to require NSEP enhancements by conditioning federal highway aid on state acceptance of such standards. Or, Congress could exercise its power of eminent domain which would ensure that any fiber installations on Interstate highways were enhanced.

Do the ROWs Offer a Sufficient Cost Advantage?

Even though there may be as much as \$5000 per mile (one-time charge) available for ROW payment after accounting for enhancements,⁴ we cannot definitively say this will be sufficient inducement for all states to open their ROW. On one hand, the \$5000 value is roughly five times the average U.S. payment for easements on rural land. On the other hand, it is only about one-half the average payment made to obtain access to toll roads in Illinois, Indiana, and Ohio that are physically very similar to Interstate freeways. Consequently, about all that can be said is that the amount available appears to be within a feasible range. What individual states will demand is uncertain. Those that place a premium on safety and traffic flow or expect to incur significant administrative and policing costs may demand more than \$5000 per mile before they will grant access. On the other hand, those states

⁴This value represents an *average* per-mile payment in a rural long-haul environment and assumes median installation, a stipulated level of hardening, and no competition from the railroads.

that need revenue or place a premium on such relatively abstract concepts as contributing to the national security and promoting economic growth may be willing to accept less than \$5000 per mile.

Will the Carriers Find the Proposal Economically Attractive?

Given the fiber-optics construction that has already been completed or will be completed in the next year or two, as well as the capability to increase route capacity by upgrading electronics rather than laying new cable, we believe the carriers will not be interested in a full backbone network, but rather only a limited number of heretofore unbuilt routes.

Overall Feasibility

Without congressional action, the conclusions reached regarding the ROW continuity and enhancement issues are fairly pessimistic. The difficulties could be largely overcome, however, if Congress could be persuaded to pass legislation either: (1) tying federal highway aid to a state's acquiescence in the development of a hardened fiber-optics telecommunications backbone or (2) exercising its power of eminent domain. Nevertheless, possible congressional action addresses only the institutional obstacles; it cannot guarantee a cost advantage or carrier interest. As a result, it is our opinion that the proposed barter concept is unlikely to result in anything other than a number of isolated segments irrespective of congressional action.⁵ However, even those isolated segments could help increase the post-attack connectivity of the network by (a) providing the system with some hardened, and therefore, more survivable links, and (b) potentially increasing the redundancy in the network (to the extent that interstate routes supplement rather than substitute for other ROW routes).

⁵It is very probable, however, that there would be a larger number of isolated segments with congressional action than without.

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CONTENTS

PREFACE	iii
SUMMARY	v
ACKNOWLEDGMENTS	xi
FIGURES	xvii
TABLES	xix
Section	
I. INTRODUCTION	1
Study Objective	1
Background	2
Fiber-Optics Technology	6
Interstate Highways	11
The Exchange Concept	17
Historical Perspective	19
II. FRAMEWORK FOR ANALYSIS	21
Network Components	22
Reliability of Major Networks in Peacetime Emergencies	24
Threats to Communications Posed by Nuclear Attack . . .	25
The Potential Contribution to NSEP of a Hardened Fiber-Optics Backbone	26
Conditions Necessary for Obtaining a Continuous Hardened Backbone	27
III. CONCERNS OF HIGHWAY OFFICIALS	28
Safety and Traffic Flow	28
Relocation Costs	34
Liability	38
Additional Costs to States	40
Proliferation	41
IV. ESTABLISHMENT OF RIGHT-OF-WAY CONTINUITY	44
Voluntary Federal/State Cooperation	44
Induced State Cooperation	65
Compelled State Cooperation	67
Summary	72

V.	AUTHORITY TO REQUIRE NSEP ENHANCEMENTS .	74
	Voluntary State Adoption of Standards	74
	Federal Imposition of Standards	74
	Summary	76
VI.	ESTIMATED COSTS OF INSTALLING FIBER-OPTICS SYSTEMS ON INTERSTATE AND ALTERNATIVE TYPES OF RIGHT-OF-WAY	77
	Sources of Cost Data	77
	Cost Categories	77
	Types of ROW Considered	78
	Cost Figure of Merit	79
	Baseline System	79
	Costs for Currently Used ROW Types	80
	Costs Associated with Installing on Interstate ROW	81
	Determination of Funds Available for Interstate ROW Payment	85
	Cost As a Function of the Number of Fibers Per Cable . .	86
	Summary	88
VII.	MARKET VALUE OF INTERSTATE HIGHWAY RIGHT-OF-WAY	90
	The Relevant Market	90
	Value of the Right-of-Way	91
	Division of ROW Values	93
	Assessing the Adequacy of Potential Interstate ROW Payments	94
	Assessing Carrier Interest in Proposed Exchange Concept	98
	Effects on Competition in the Telecommunications Industry	99
	State Management of a ROW Offering	100
VIII.	FINDINGS	102
	Concerns of Highway Officials	102
	Feasibility of Barter Concept	103
	Additional Federal Options for Obtaining Hardened Fiber-Optics Backbone	107
Appendix		
A.	BACKGROUND ON NCS AND FHWA	109
B.	REFERENCES ON FIBER-OPTICS COMMUNICATIONS	116

C.	MISCELLANEOUS SUPPORTING DOCUMENTATION	118
D.	CONSULTANT'S REPORT: ASSESSING THE POTENTIAL EFFECT OF FIBER-OPTICS INSTALLATIONS ON INTERSTATE TRAFFIC FLOW AND SAFETY	162
E.	EXEMPLARY TOLL ROAD AUTHORITY/ COMMUNICATION COMPANY AGREEMENT . . .	183
F.	DOCUMENTATION OF GEORGIA FEE DETERMINATION	208
G.	SUPPORTING COST DATA	213

FIGURES

1. Hypothetical Telecommunications Backbone	4
2. Components of Digital Fiber System	8
3. Fiber Optics Long-Haul Systems Planned and In-Place . . .	10
4. The National System of Interstate and Defense Highways .	12
5. Message and Control Networks Within Long-Distance Portion of Public Switched Network	23
6. Potential Benefits of a Hardened Fiber-Optics Backbone . .	26
7. State Highway Law Survey	54
8. State Fee Structures	58
9. Results of Survey of State Governors	63
10. Influence of Governors Over State Highway Departments .	64
11. Location Concepts Within Interstate ROW	78
12. Cost as Function of the Number of Fibers per Cable	88
A.1. NCS Organization	111
A.2. FHWA Organization	114
D.1. Typical Placement of Edge Drains	173
D.2. Edge Drain Trenching Machine	173
D.3. Placing the Edge Drain Pipe	174
D.4. Backfilling the Trench	174
D.5. Preparation for Repaving the Pavement Cut	175
D.6. New Jersey Concrete Barrier	177
G.1. Typical Cable Installation Vehicle	217
G.2. Crossing of Interchanges and Grade Separations	220
G.3. Surface Enclosure	221
G.4. Underground Enclosure	223

TABLES

1. Emergency Systems Dependent on Common Carriers for Transmission	11
2. Advantages and Drawbacks of Longitudinal Occupancy of Interstate Highway ROW by Underground Utilities	16
3. Historical Perspective	20
4. U.S. Long-Distance Telecommunications Carriers	22
5. U.S. Accident and Fatality Data (1983)	29
6. Fatal Accidents in Interstate Work Zones (1983)	31
7. Fatal Accidents in Work Zones on Non-Interstate Road Systems	31
8. Statutory Authority Relating to Reimbursement of Public Utility Relocation Expense	36
9. Longitudinal Use of Freeway Rights-of-Way: FHWA Approved Special Case Exceptions, 1983—1986	48
10. State Survey Sample	53
11. State Highway Law Survey	57
12. Results of Survey of State Highway Departments	60
13. Summary of Options for Obtaining Backbone ROW Continuity	73
14. Summary of Options for Obtaining NSEP Enhancements	76
15. Installed Cost on Currently Used ROW Type	81
16. Installed Costs Using Interstate ROW	82
17. Enhancement Levels	83
18. Costs of Enhanced Interstate Systems	85
19. Funds Available for Interstate ROW Payment	87
20. Right-of-Way Fees on Toll Roads and Other Facilities	95
21. Key Feasibility Issues	107
A.1. Federal-Aid Systems: Mileage and Travel	113
A.2. Highway Trust Fund Receipts	115
A.3. Federal Aid Highway Program Authorizations	115
D.1. Accident and Fatality Data for 1984	164
D.2. Fatal Accidents Involving Utility Poles on Interstate Freeways	165
D.3. Fatal Accidents in Construction/Maintenance Zones by Functional Classification	166
D.4. Traffic Projections	168
G.1. Carriers Contacted for Cost Data	213
G.2. Estimated ROW Costs for Rural Private Land	216
G.3. Cable Procurement Costs	217

G.4. Median Installation: Cost of Crossing Interchanges and Grade Separations	222
G.5. Interstate Cable Installation Costs	222
G.6. Costs of Alternative Regenerator Configurations	224

I. INTRODUCTION

STUDY OBJECTIVE

Among its responsibilities, the National Communications System (NCS) is charged with the restoration and reconstitution of domestic telecommunications services in the aftermath of a nuclear war. Devastation will be widespread in such a situation. Large segments of the national telecommunications network will have been destroyed. It is assumed, however, that there will be surviving pockets of population that will be seeking information about medical services and food and attempting to assess the extent of the damage. Realistically, "reconstitution" of the telecommunications infrastructure in such an environment will take the form of improvising with whatever is left—from two-way radios to surviving segments of the public switched network. There are, however, a number of measures that could be undertaken in advance to facilitate such reconstitution. One such measure is to develop a hardened "backbone" network—a network constructed so that it is more likely to survive the effects of a nuclear war than the typical commercial installation—with perhaps two east-west legs and three north-south legs crisscrossing the continental United States.

Recently, the NCS has proposed a concept for obtaining a hardened backbone, using fiber-optics technology, at no out-of-pocket cost to the government. This proposal would exchange access to Interstate right-of-way (ROW), which telecommunications companies are currently prohibited from using¹ but which is quite attractive to them from the perspective of installation cost savings, for the hardening of fiber-optics systems using such ROWs.² The objective of this study was to assess the *feasibility* of the proposed concept.

¹Current Federal Highway Administration (FHWA) policy prohibits longitudinal use of Interstate ROW by utilities except when extreme economic or environmental hardship can be demonstrated (see 23 CFR 645, Subpart B; i.e., Code of Federal Regulations, Title 23, Part 645, Subpart B).

²Conceptually, other types of public highways (i.e., major arterials other than Interstates) are also potential candidates for hardened fiber-optics routes. However, for a variety of reasons, the *long-haul* carriers do not find non-Interstate highways to be a particularly attractive option (relatively high initial installation cost and uncertainty with respect to responsibility for relocation and damage). Moreover, since there are not currently any blanket prohibitions with respect to utility use of non-Interstate highway ROW, the federal government has no leverage with which to bargain for enhancements. Consequently, although non-Interstate highways are a useful point of comparison in assessing the economic viability of alternative ROW types, it is the Interstate highways that are properly the focus of this feasibility study.

BACKGROUND

Objective of National Security/Emergency Preparedness Telecommunications Policy

In highly summarized form, the objective of national security/emergency preparedness (NSEP) telecommunications policy is the development of a telecommunications infrastructure that supports the President in his roles as Commander-in-Chief, Head of State, and Chief Executive, in all possible situations of stress—before, during, and after:

- Natural disasters (e.g., hurricanes, earthquakes);
- International and domestic crises (e.g., the hijacking of the Achille Lauro, the accident at Three Mile Island);
- Conventional war (i.e., for troop and equipment deployment and battle management); and
- Nuclear war.

Guidance for NSEP telecommunications comes primarily from: (a) National Security Decision Directive Number 97 (NSDD-97), "National Security Telecommunications Policy," August 3, 1983; and (b) Executive Order 12472, "Assignment of National Security and Emergency Preparedness Telecommunications Functions," April 3, 1984.³ NSDD-97 focuses exclusively on national security telecommunications whereas Executive Order 12472 covers the full range of national security/emergency preparedness telecommunications. Both NSDD-97 and E.O. 12472, however, declare all of the nation's domestic and international telecommunications resources, regardless of ownership (government, commercial, or private), to be essential elements in support of U.S. national security policy and strategy. Brief overviews of the two Presidential documents follow.

National Security Decision Directive Number 97. As spelled out in NSDD-97, the objective of national security telecommunications policy is the development of a telecommunications infrastructure that will support the President in his responsibilities as Commander-in-Chief, Head of State, and Chief Executive. More specifically, the nation's telecommunications capabilities should provide for:

1. The gathering of intelligence and the conduct of diplomacy on a worldwide basis;

³General guidance with respect to meeting defense and essential civilian needs during national security and major domestic emergencies is provided in NSDD-47, "Emergency Mobilization Preparedness," July 22, 1982.

2. The assured connectivity of the National Command Authority and military forces; and
3. The continuity of government during and after crisis situations and the recovery of critical national functions following crisis situations.

Clearly, a recognized and unquestioned capability to satisfy these functions is an essential element of U.S. deterrence.

Executive Order 12472. By virtue of Executive Order 12472, it is the mission of the National Communications System⁴ to assist the President, National Security Council, Office of Science and Technology Policy, and Office of Management and Budget in:

1. The exercise of their wartime and nonwartime emergency functions, and their planning and oversight responsibilities; and,
2. The coordination of the planning for and provision of national security and emergency preparedness communications for the federal government under all circumstances, including crisis or emergency, attack, recovery, and reconstitution.

The Concept of a Hardened Backbone

The NCS-specified focus for this study is the restoration and reconstitution of domestic telecommunications services in the aftermath of a nuclear war, a worst-case scenario. Large segments of the power grid and telecommunications network will have been destroyed. We assume, however, that there will be surviving pockets of population that will be seeking information about medical supplies and services, food, and the extent of the devastation. "Reconstitution" of the telecommunications infrastructure in such an environment will take the form of improvising with whatever is left—from two-way radios to surviving segments of the public switched network.

One approach to facilitating communication among the surviving centers of population is to develop a hardened "skeleton" network—a network more likely to survive the effects of a nuclear war than the typical commercial installation, with perhaps two east-west legs and three north-south legs. Of course, the more of the nation's emerging telecommunications fiber transmission infrastructure that is hardened,

⁴The NCS is a confederation of 22 federal government departments and agencies that was chartered by E.O. 12472. Taken together, the telecommunications assets of these 22 member organizations comprise the bulk of the telecommunications resources owned or leased by the federal government. Additional information on the NCS may be found in App. A.

the more survivable the total telecommunications system will be. The Office of the Manager, NCS, is therefore concerned with maximum hardening of all possible paths. The *minimum* backbone illustrated in Fig. 1 covers 34 states and roughly 10,000 miles. Not surprisingly, such a backbone, of coaxial cable, currently exists.⁵ However, because some segments of the coaxial backbone are now almost 25 years old and a more capable and economic cable type is now available (fiber), it is not certain how much longer its owner (AT&T) will continue its operation. Consequently, the Office of the Manager, NCS, is looking at the possibilities for supplementing the coaxial backbone in the short run⁶ and potentially facilitating the hardening of its replacement in the long run. The technology that the Office of the Manager, NCS, wants to use is

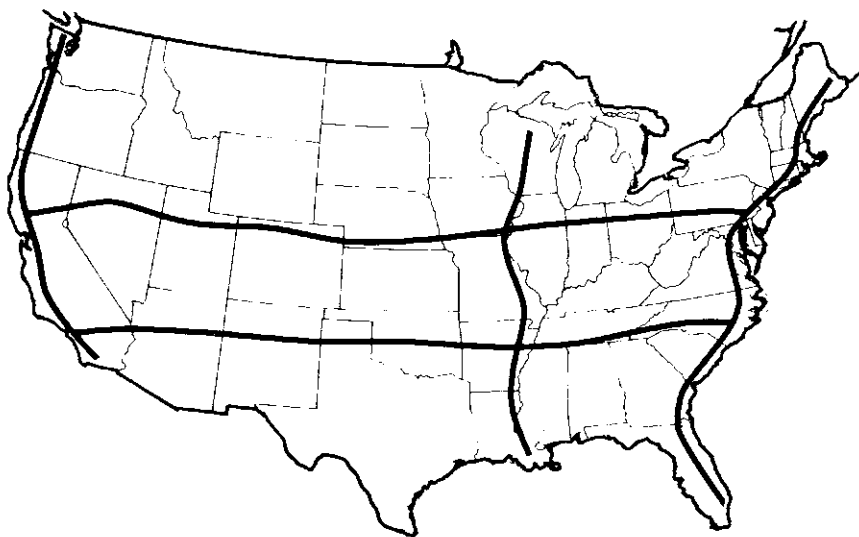


Fig. 1— Hypothetical telecommunications backbone

⁵The actual route structure is proprietary to AT&T.

⁶Possible reasons for supplementing the current hardened coaxial system are (a) the coaxial system has limited capacity, (b) the coaxial routes avoid population centers, and (c) redundant transmission modes may be effective complements (the coaxial cable backbone has hardened operation centers and 30-day endurance).

fiber optics, now the dominant U.S. long-haul transmission mode and likely to continue to be so into the distant future.⁷

Study Context

The government can "acquire" a hardened backbone in one of two basic ways: (a) constructing a hardened, dedicated federal government system or (b) increasing the level of hardness on selected commercial routes. Primarily for economic reasons, the latter option (and the one used to get the hardened coaxial backbone) is currently favored by the federal government. Furthermore, circumstances seem quite advantageous for such an approach—the U.S. telecommunications industry is in the midst of installing an extensive national network using a relatively new transmission mode—optical fiber. But as one would expect, the emerging commercial fiber network has perceived vulnerabilities with respect to a nuclear attack. Moreover, in the post-divestiture era, where competition tends to dominate all other considerations, the carriers are not going to voluntarily incorporate hardening measures that will increase their costs.⁸ So, if hardening is to be obtained, there must be other incentives for the carriers. Consequently, in its search for alternatives, the NCS has proposed a solution for acquiring a hardened backbone at no out-of-pocket cost to the federal government. This proposal would exchange access to Interstate right-of-way, which carriers are currently prohibited from using but which is quite attractive to them from the perspective of installation cost savings, for the hardening of fiber systems using such ROWs. Thus, the goal of this study was to assess the *feasibility* of the proposed solution. It was not, however, to assess its desirability since we did not evaluate it in the context of other means for facilitating long-haul domestic communications in the post-attack environment. Other means might include:

- AMBER (AM Broadcast Emergency Relay): proposed long-haul, nationwide digital network formed by internetting existing commercial AM radio broadcast stations. Its purpose is to

⁷According to Dr. Robert W. Lucky, executive director of the communications sciences research division, AT&T Bell Laboratories is phasing satellite communications out of its commercial planning and is concentrating on fiber optics. Speaking at a presentation sponsored by the Institute of Electrical and Electronic Engineers (IEEE), Lucky said that the United States will be tied together by light waves by 1990, and that "all point-to-point communications will eventually be based on fiber optics." ("Bell Labs De-Emphasizes Satellite Communications," *Microwave System News*, July 1985.)

⁸Prior to divestiture, the federal government could recommend specific hardening measures (and even specific routes) to AT&T, which the company would voluntarily incorporate, rolling any extra costs into its rate base (with the concurrence of the Federal Communications Commission).

provide emergency communications for civilian and military users in both pre- and post-nuclear attack environments (see Edward Bedrosian and Elwyn Harris, *AM Broadcast Emergency Relay (AMBER): Network Technical Feasibility Study*, The RAND Corporation, N-2220-ARPA, December 1984).

- NETS (Nationwide Emergency Telecommunications System): Proposed augmentation of the public switched network to reestablish connectivity for governmental users on a damaged network in times of national emergency, via the imposition of non-standard connections. Special-purpose software and hardware at network switches would enable the system to route calls around damaged areas (links and switches) using the surviving facilities of several carriers.
- Diversion of dedicated military command and control systems to purposes of general reconstitution (e.g., the Ground-Wave Emergency Network now being constructed for the Strategic Air Command).
- Prepositioning of portable satellite earth stations and microwave relay towers in protected locations.
- Maintaining/upgrading existing coaxial cable backbone.
- Development of integrated amateur radio network.

FIBER-OPTICS TECHNOLOGY

The U.S. telecommunications network has three principal transmission modes: satellite, microwave relay, and cable. Within the cable category there are three subtypes: paired copper wire, coaxial cable, and optical fiber. An optical fiber is a hair-thin strand ($\sim 1/8$ mm outside diameter) of glass, composed primarily of silicon. It consists of a glass core through which the light wave travels (diameter less than $1/100$ mm) and a layer of cladding that contains the light. Based on commercially available electronics, individual fiber pairs can carry up to 8000 voice channels.⁹

For protection during installation, as well as in the operational environment, individual fibers are bound together in a cable. Cables used in long-haul transmission typically have 24 to 36 fibers, although they may have up to 144 fibers.

Compared with other transmission modes, fiber has several advantages:

⁹Assuming 565 Mbps electronics and 68,000 bits per voice channel.

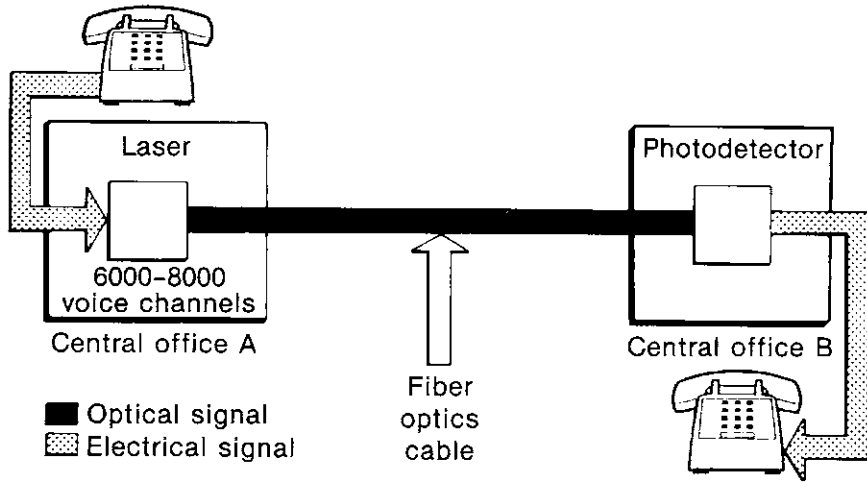
- *Relatively immune to interference.* Because fiber optics operates in the light-wave region of the electromagnetic spectrum, it is less susceptible to electrostatic (lightning) and electromagnetic (power lines, machinery) interference than copper cable, microwave relay, and satellite modes.
- *Difficult to tap.* Because there is virtually no leakage of electromagnetic radiation from fiber, tapping is extremely difficult without detection.
- *Small size and weight.* Because of its small size and weight, fiber has installation advantages relative to other cable types. In urban areas, the use of fiber can result in better utilization of limited conduit space. In rural areas, fiber can be “plowed” into the ground in a fairly fast (on the order of 6 to 10 miles per day in the median) and unobtrusive manner (trenching not required).
- *Low cost.* And, of course, fiber’s ultimate advantage is the fact that on high-volume, point-to-point routes, it has the lowest cost per unit of bandwidth of any transmission mode.

Components of Digital Fiber System

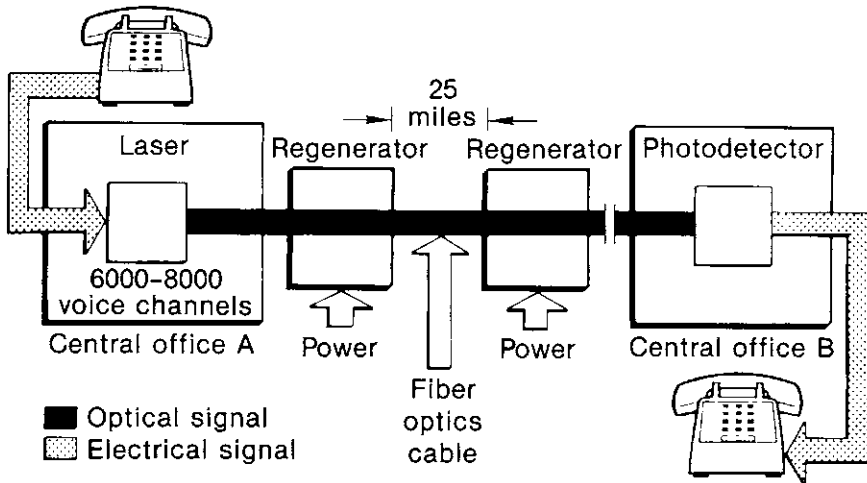
The key components of a digital fiber system are shown in Fig. 2(a). An individual telephone call originates as an electrical current at a user’s home or business and travels to a telephone switching office over a local loop of copper wires. This signal requires only a small capacity—4 kHz for a voice telephone call. Other signals—for computer data, facsimile images, and television—require greater bandwidth and may be delivered by coaxial cable. At the switching office, each signal is converted to digital form. Then, to effectively use the very high bandwidth (capacity) of a single fiber, the digital pulses are combined with similar digital pulses from other users in a multiplexer.

The multiplexed electrical signals are next converted to pulses of coherent light by a laser and fed into one fiber that typically has a capacity of 6000 to 8000 voice circuits (a bandwidth of 417 Mbps to 565 Mbps), depending on design. To create a continuous light guide, each fiber must be spliced to another segment of cable every 1-1/2 to 2 miles. These splices are typically located in small underground boxes (not depicted in Fig. 2).

At the end of the cable, detection and demultiplexing equipment converts the light pulse back into electrical signals and divides the bundled signals into their individual components. These signals are then routed by the destination telephone office to their final destinations. Signals can also be inserted and removed from the fiber-optics



(a) Distances less than 25 miles (approximately)



(b) Distances more than 25 miles (approximately)

Fig. 2—Components of digital fiber system

system at intermediate regenerator stations, if they are equipped with multiplexing equipment.

The concept outlined above is suitable for short distances—say 25 miles or less. However, for longer distances, loss of signal power results in the need for signal regeneration (see Fig. 2(b)). Regenerators are typically enclosed surface structures (although they could be buried) that house receiving photodetectors, transmitting lasers, and supporting electronics. They are roughly 10 ft × 20 ft × 8 ft. Power, typically on the order of less than 1 kilowatt, is supplied by the local grid.

One aspect of fiber technology that needs to be emphasized is that bit transmission rates are limited not so much by the quality or number of fibers but rather by the electronics packages. Today's commercial long-haul bit rate is between 400 and 565 Mbps (6000–8000 voice channels per fiber pair). Next year, electronics packages capable of a 1.7 Gbps transmission rate (25,000 voice channels per fiber pair) will be commercially introduced. Additionally, rates of 8 Gbps (120,000 voice channels per fiber pair) have been demonstrated under laboratory conditions. And the 8 Gbps rate is still less than 1/10,000 of the theoretical bandwidth. Consequently, for the foreseeable future, it should be possible to increase system capacity by updating the electronics packages without the necessity for laying additional cable.¹⁰

Finally, a disadvantage of fiber is that because it is a terrestrial system, it requires expensive and hard-to-get right-of-way. Fiber installers are currently using private land, railroad, and public roads.

Rapid Emergence of Fiber Optics as Dominant Long-Haul Transmission Mode

Figure 3 shows planned and in-place long-haul fiber-optics routes. Although not so indicated on the map, many of the routes have been completed and most of the others will be in service by 1990. Although the first commercial demonstration of fiber optics took place in 1977, it was not until 1984 (the year of divestiture) that expansion really took off. By the end of 1986, fiber optics was expected to account for over 80 percent of U.S. telephone capacity with a network covering 2.3 million fiber miles or the equivalent of 7.8 billion voice circuit miles.¹¹ And the expansion is not yet complete.

¹⁰More detailed information concerning the fundamentals and evolution of fiber-optics technology may be found in the references listed in App. B.

¹¹"Fiber optics Dominates Telephone Capacity," *Fiber optics Marketing Intelligence Newsletter*, Kessler Marketing Intelligence, Newport, Rhode Island, July 1986.

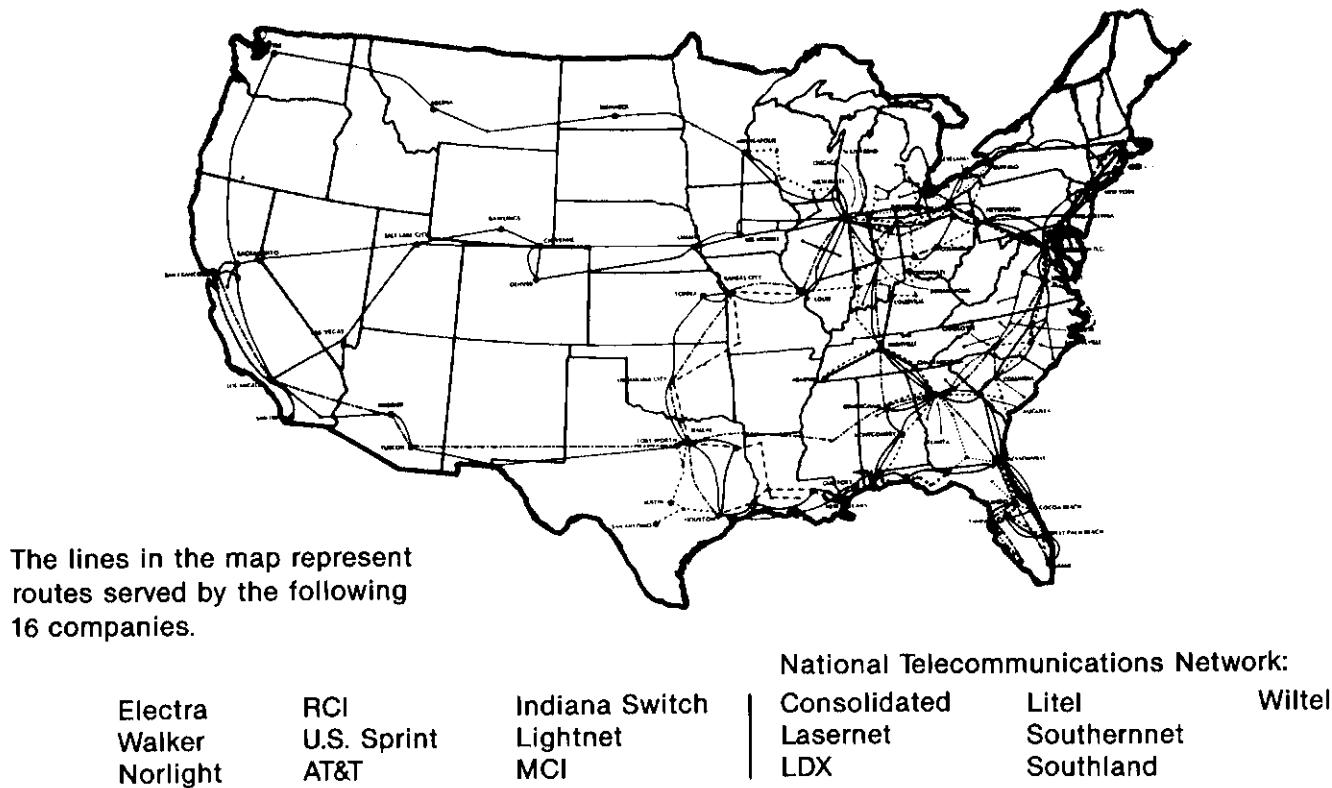


Fig. 3—Fiber optics long-haul systems planned and in-place

The importance of the common carrier network to households and businesses is well known. However, what is not as well known is the extent of the federal government's reliance. The NCS estimates that roughly 95 percent of the federal government's day-to-day domestic telecommunications is dependent on the common carrier facilities. Furthermore, many specialized emergency systems are also dependent on the common carriers including medical, fire, police, and the Civil Defense Attack Warning System. A more complete listing is provided in Table 1.

INTERSTATE HIGHWAYS

Background

The National System of Interstate and Defense Highways is shown in Fig. 4. The total length of the system is 42,500 miles, of which approximately 32,500 miles are classified as rural or intercity, and

Table 1

EMERGENCY SYSTEMS DEPENDENT ON COMMON CARRIERS FOR TRANSMISSION

National Weather Service/distribution of weather information (AFOS)
Automatic Voice Network (AUTOVON)
Automatic Digital Network (AUTODIN)
Civil Defense National Voice System (CDNAVS)
Emergency Medical
Emergency Fire
Emergency Police
Federal Secure Telephone System (FSTS)
Federal Telecommunications System (FTS)
Improved Emergency Message Automatic Transmission System (IEMATS)
JCS Alerting Network (JCSAN)
Marine and Aircraft Emergency Radio
National Airspace Data Interchange Network (NADIN)
National Warning System (Civil Defense Attack Warning System) (NAWAS)
Nuclear Powerplant Emergency Notification System
Rapid Warning and Coordination System/storm warning (RAWAC)

SOURCE: Robert F. Daly et al., *A Review of National Security-Emergency Preparedness Telecommunications Policy*, SRI International, SRI Project 1655, February 1981, p. 100.

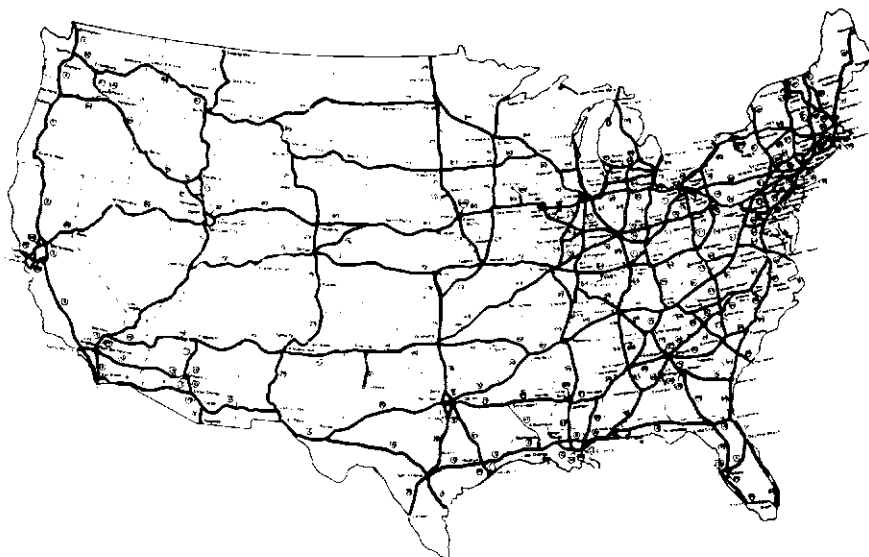


Fig. 4—The national system of Interstate and defense highways

10,000 miles as urban or intracity.¹² The Interstate program, originally authorized by Congress in 1944, is the largest federal-aid highway program in terms of funding. Four billion dollars per year, or about 30 percent of all federal-aid highway funds, are authorized for it.

As described in a Department of Transportation publication:

The Interstate program has explicitly stated goals—the initial construction to the latest and safest design standards of a 42,500-mile connected network of freeways designed to meet the anticipated traffic needs 20 years into the future. These roads, in both rural and urban areas, connect most of the Nation's cities of 50,000 or more population, *serve the needs of national defense* [italics added], and connect at suitable border points with key Canadian and Mexican highways.

¹²Interstate highways are a subset of the more general category of freeways (divided highways for through traffic with full control of access). In addition to the 42,500 miles of Interstate freeway, the United States has roughly another 10,000 miles of non-Interstate freeway.

Interstate freeways have divided roadways normally with wide medians separating opposing lanes of traffic. Traffic lanes are 12 feet wide. They have no traffic lights or stop signs, no intersections at grade, and no sharp curves or steep grades. Access and egress are completely controlled.

Advantages associated with the Interstate System can be divided into user and nonuser benefits. User benefits encompass those gains which accrue to travelers using the System. In large part, they include savings in travel time, energy consumption, and operating costs, reductions in accidents and congestion in the traffic corridor, and faster and more economical movement of goods.

Perhaps the most striking example of user benefits is reflected in the low accident rates on Interstate facilities. The safest of all road systems, the Interstate routes are nearly three times safer than non-Interstate routes in terms of fatalities and almost four times safer when considering injury-producing accidents.

Other benefits include improved opportunities for leisure activities, for work, and for residential location by essentially enlarging the area people can reach within a certain time.

Nonuser benefits include more effective land use and a greater diversity of goods and services at lower cost.

When the Interstate program was established, Congress provided that most Federal-Aid Interstate System funds could be used only for the initial construction of the System. The reasoning was that completion should be accomplished at the earliest possible date. Although funds could be spent to improve roads open to traffic, this was permitted only to incorporate the latest design standards and safety features into those routes.

At the same time, some 2,300 miles of toll roads, tunnels, and bridges that already existed in Interstate System corridors were taken into the System. As a result, motorists must pay tolls on a few Interstate routes, while the rest of the System is free. (Under law, no Federal funds can be used in construction of a toll facility, nor can they be used for improvements to a toll facility except under very special circumstances.)¹³

Ownership of ROW

With one exception (South Dakota), Interstate ROW is owned by the individual states.

¹³*America on the Move*, Department of Transportation, September 1984, p. 7.

Current ROW Policy

Even though the states own the Interstate ROW, policy regarding its use is set by the Federal Highway Administration (FHWA), which also administers the \$10 billion-plus Federal-Aid Highway Program.¹⁴ The FHWA "enforces" its ROW policy through its power to withhold federal-aid highway money for noncompliance. Current FHWA policy regarding the accommodation of utilities within the right-of-way of federal and federal-aid highway projects is contained in 23 CFR 645, Subpart B. Section 645.209(c) requires that all utility installations on freeway right-of-way conform to the provisions of the AASHTO (American Association of State Highway and Transportation Officials)¹⁵ publication, *A Policy on the Accommodation of Utilities Within Freeway Right-of-Way*, 1982. That portion of the AASHTO policy dealing with *new* installations is as follows:

New utilities will not be permitted to be installed longitudinally within the control of access lines of any freeway, except that in special cases such installations may be permitted under strictly controlled conditions. However, in each such case the utility owner must show that:

- A. The accommodations will not adversely affect the safety, design, construction, operation, maintenance or stability of the freeway;
- B. The accommodation will not be constructed and/or serviced by direct access from the thru traffic roadways or connecting ramps;
- C. The accommodation will not interfere with or impair the present use or future expansion of the freeway; and,
- D. Any alternative location would be contrary to the public interest. This determination would include an evaluation of the direct and indirect environmental and economic effects which would result from the disapproval of the use of such right-of-way for the accommodation of such utility.

¹⁴Additional information on the FHWA, organizationally a part of the Department of Transportation, may be found in App. A.

¹⁵23 U.S.C. 109(b) (i.e., U.S. Code, Title 23, Section 109(b)) states that "the geometric and construction standards to be adopted for the Interstate System shall be those approved by the Secretary in cooperation with the State highway departments." Consequently, the Secretary must, at a minimum, consult with the state highway departments regarding such standards including those pertaining to utility accommodation. In the past, this consultation has generally taken the form of adopting the policies approved by the American Association of State Highway and Transportation Officials (AASHTO). Membership in AASHTO is voluntary, but all 50 states (plus Puerto Rico and the District of Columbia) are members at this time. AASHTO policies and positions are adopted by a two-thirds majority vote.

Between January 1983 and the first quarter of 1986, the FHWA approved 53 special-case exceptions for the longitudinal use of federal-aid freeways (both Interstate and non-Interstate). Forty-nine of the 53 exceptions were for one mile or less and only one was for over five miles. Since 1960 it is estimated that nationwide the FHWA has approved approximately 250 requests to allow longitudinal utility use. It is also estimated that during this same period that nationwide the FHWA has formally denied approximately 150 requests for such use (the number of formal denials is relatively small since in most cases the state highway agencies themselves will deny a utility's request for longitudinal use of a freeway and the matter is not formally presented to the FHWA).

Advantages and Drawbacks of Longitudinal Occupancy of Interstate Highway ROW by Underground Utilities

The advantages and drawbacks of permitting underground utilities¹⁶ longitudinal access to Interstate highway ROW are listed in Table 2. The listing represents a compilation that applies to underground utilities in general and is not limited to fiber optics. Note that the relative importance of these advantages and drawbacks will vary with a number of factors including:

- Where in the ROW the utility is located (median or fence line);
- The nature of the ROW that would be used if the Interstate were not available;
- Whether the Interstate is in a rural, urban, or suburban environment;
- The type of utility being installed including the volatility of the medium being conveyed, rate and physical obtrusiveness of installation, and frequency and duration of maintenance;
- The total number of utility installations in-place and planned; and finally,
- The nature of state laws (or the contractual agreement) with respect to relocation costs and liability.

¹⁶We have assumed that above-ground utilities (aerial power and aerial communication cables) would not be permitted in the ROW on the basis of aesthetics and safety. Furthermore, any above-ground support structures (e.g., electrical substations, pumping facilities, regenerators) required for basically underground utilities would be located either off the ROW or at the fence line where off-road access could be obtained.

Table 2

ADVANTAGES AND DRAWBACKS OF LONGITUDINAL OCCUPANCY OF
INTERSTATE HIGHWAY ROW BY UNDERGROUND UTILITIES

Advantages	
<i>To utilities and consumers</i>	
Economy in construction	
Most direct route between cities	
Limited access (in particular, no direct access by businesses or residences)	
Relatively few through cross-roads	
Favorable grades and alignment	
Lower maintenance costs due to protected environment (fence, patrols)	
Lower negotiation costs (single landowner to deal with)	
<i>To state governments</i>	
Source of revenue	
<i>To the general public</i>	
Possible preservation of undisturbed land (assuming alternative ROW is undisturbed)	
Less disruption to businesses and residences (assuming that non-Interstate highway is alternative to Interstate)	
Improved traffic safety on non-Interstate highways (assuming that non-Interstate highway is alternative to Interstate)	
Drawbacks	
<i>To Interstate motorists</i>	
Negative effect on Interstate traffic flow during initial installation and subsequent maintenance	
Negative effect on Interstate safety due to:	
Installation and maintenance activities (slow-moving utility vehicles, open excavations, stockpiled material, visual impediments such as dust)	
Nature of certain utilities (e.g., volatility of oil and natural gas)	
<i>To state highway authorities</i>	
Additional costs associated with administering permits and policing installation and maintenance activities	
Potential conflict with future widening/upgrading of Interstate facilities	
Potential for damage to roadway structures during installation and maintenance activities	
Potential for damage to utilities during highway and bridge maintenance operations with possible liability	
Possibility that presence of utilities may increase attractiveness of Interstates as enemy targets	
<i>To utilities</i>	
"Severity" of installation and maintenance conditions set by state highway authorities	
Point of access (off-road access can mean additional easement)	
Working hours (usually limited to daylight and nonrush hours)	
Off-site overnight vehicle storage (fewer working hours)	
Restoration requirements	
Presumed responsibility for relocation costs	
Uncertainty with respect to liability for damaged cables or pipelines	

THE EXCHANGE CONCEPT

What's Sought from Carriers: Incremental Hardening

Perceived Threat to Commercial Fiber Systems. The task of piecing together the surviving segments of the network will clearly be easier the more survivable the network is. In this regard, the currently emerging fiber network is perceived to be vulnerable to the following threats:¹⁷

- Above-ground components such as surface-located regenerators and cable sections attached to bridges are subject to physical destruction from the blast effects of nuclear explosions.
- Fallout radiation can cause an increase in fiber transmittance loss (more so for fibers with a relatively high phosphorous content); an increase in the bit error rate of receiver photodiodes [more so for APD (avalanche photodiode) photodetectors than for PIN (positive, intrinsic, negative) photodetectors]; and the complete failure of electronic devices such as metal oxide semiconductor devices.¹⁸
- The assumed destruction of the nation's power grid, in conjunction with the fact that carriers typically provide back-up battery power that will last for only an 8 to 16 hour period, means that surviving regenerators will not have sufficient power to operate for more than a day.

An additional potential threat to fiber systems is electromagnetic pulse (EMP) effects. Some fiber systems now being installed employ metallic strength members that can act as giant antennas that pick up and transfer energy to sensitive electronic devices. However, a recent AT&T report¹⁹ suggests that if sound engineering practices are employed, cables with metallic strength members may be used without significantly increasing the threat to electronics. In fact, the only serious shortcoming that came to light during EMP-testing of FT3C light-wave system electronics equipment was the sensitivity of the overvoltage protection circuitry in the dc power converters to electromagnetic

¹⁷Note that this study is limited to the cable and regenerators on long-haul routes. It does not consider the vulnerability associated with switches, the signaling system, local distribution networks, or equipment on customer premises.

¹⁸See *Assessment of Nuclear Fallout Radiation on FT3C Lightwave Digital Transmission System*, AT&T Bell Laboratories, NCS TIB 85-11, Holmdel, New Jersey, November 1985.

¹⁹*FT3C Multi-Mode Optical-Fiber Communications System EMP Test and Assessment*, AT&T Bell Laboratories, Final Report, NCS TIB 85-12, Holmdel, New Jersey, November 1985.

noise (resulting in system disablement). However, according to AT&T this difficulty is easily rectified by a minor modification to the power converter (placement of a filter capacitor between the gate and cathode of the silicon-controlled rectifier in the overvoltage protection circuit).

Hardening Measures. The National Communications System does not have a set of standards or guidelines for assessing the hardness of fiber-optics installations, and has contracted with the Institute for Telecommunication Sciences²⁰ for the development of such a specification. The ITS task is difficult because of the number of options that must be considered and the rapidly evolving nature of fiber technology.²¹ Based on the AT&T reports and discussions with ITS personnel, we feel that the vulnerabilities listed above could largely be alleviated by:

- Burying all system components to a depth of 36 inches to protect against blast damage and fallout radiation²² and,
- Providing a back-up power source that will automatically kick-in when needed and operate for some minimum period of time.

What's Offered in Return: Access to Interstate ROWs

Utilities have long sought access to Interstate ROWs. Interstate ROWs are almost always the shortest distance between two cities, are usually built on rock-free fill (median and shoulder), and possess limited access (no business or residential driveways or at-grade intersections), generally favorable grades and alignment, and are reasonably well-protected. Such characteristics lead to fairly low installation costs and reduced concerns about vandalism and the possibility of being damaged by errant backhoes.

²⁰The Institute for Telecommunication Sciences, located in Boulder, Colorado, is organizationally part of the National Telecommunications and Information Administration of the U.S. Department of Commerce.

²¹A preliminary report identifying the factors that influence stress-resistance in a fiber-optics system has been published, however; see David F. Peach, *Trends Toward a More Stress-Resistant Fiber Optic Telecommunication System*, NTIA Technical Memorandum 86-116, August 1986. (Subsequent to the completion of the analysis undertaken for the RAND study but just prior to the publication of this Report, the following final documentation was published by the Institute:

- Joseph A. Hull, *NSEP Fiber Optics System Study, Background Report: Nuclear Effects on Fiber Optic Transmission Systems*, NTIA Report 87-227, November 1987, and
- David F. Peach, *Multitier Specification for NSEP Enhancement of Fiber Optic Long-Distance Telecommunication Networks*, NTIA Report 87-226, December 1987.)

²²At 1 MeV energy levels, 36 inches of sand provides approximately the same protection against fallout radiation as six inches of lead. Forty-eight inches of sand provides the equivalent of eight inches of lead.

The problem is that current FHWA policy prohibits longitudinal use of Interstate ROW by utilities except when extreme economic or environmental hardship can be demonstrated. Thus, the NCS felt that between this prohibition and the previously described carrier interest lay the possibility of an exchange: a relaxation in the federal Interstate access policy for national security hardening of fiber systems using ROWs.

The Exchange Equation

The implicit assumption in the exchange concept is that the costs of the ROW and enhancements on the Interstate would more than be offset by the savings associated with the cheaper installation on Interstates such that the total Interstate cost would be less than (or equal to) the total cost of the next best alternative. Presumably, under such a scheme everybody would be better off—the carriers would have lower costs (to pass on to consumers), the states, which own the ROW, would gain revenue, and the country as a whole would have a more survivable telecommunications infrastructure.

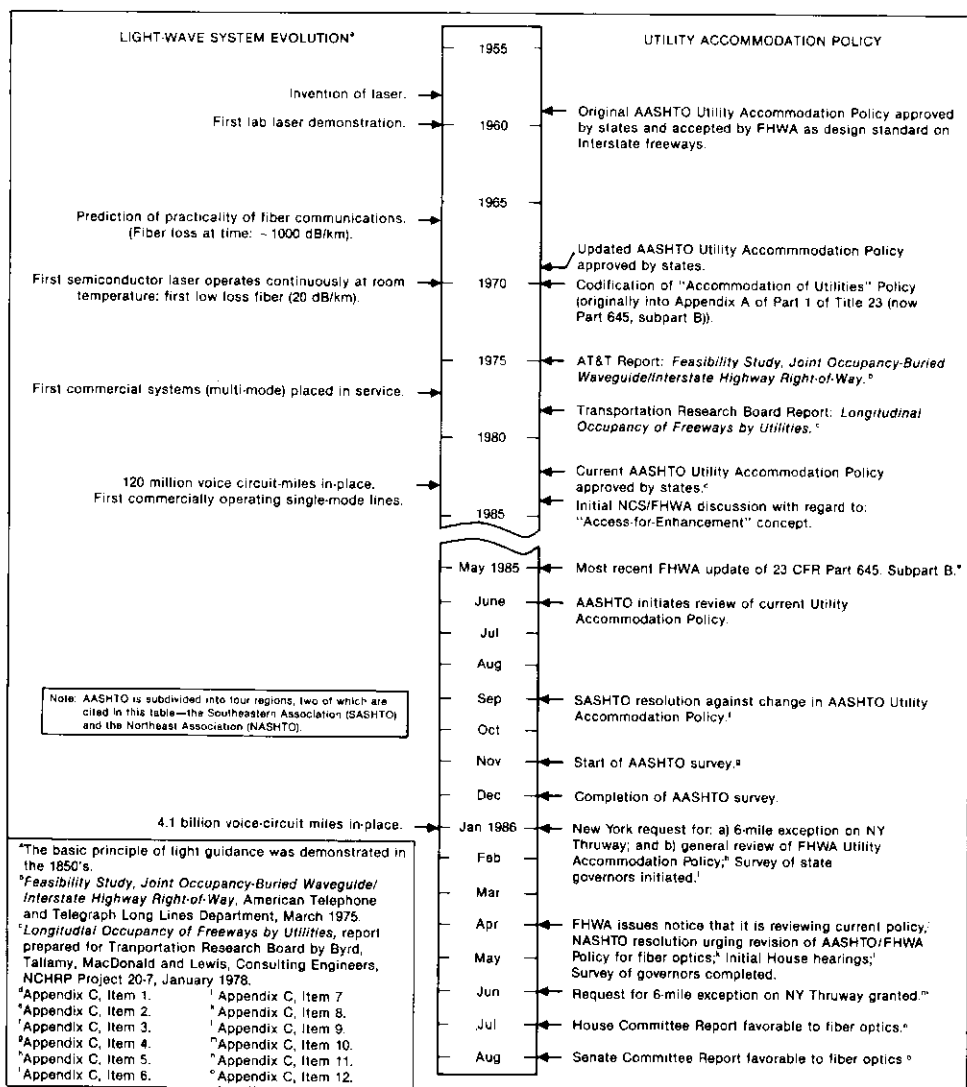
HISTORICAL PERSPECTIVE

A timeline of key events with respect to the two key study components—fiber-optics communications and utility use of Interstate freeway ROW—is presented in Table 3. Two points deserve emphasis. First is the fact that the development and commercialization of fiber optics have taken place over a relatively short period of time.²³ In particular, as indicated by the growth in voice-circuit miles between 1985 and 1986, the long-haul carriers have been installing fiber at an extremely rapid rate. Second is the fact that AASHTO has reviewed its utility accommodation policy twice (in 1969 and again in 1982) since it was originally adopted in 1959. In both instances, (a) the basic principles underlying the policy were reaffirmed (AASHTO's current policy is essentially the same as the one developed in 1959 at the onset of the Interstate program), and (b) the FHWA in turn adopted the updated AASHTO policy as its own.²⁴ Thus, the policy has gone virtually unchanged for more than 25 years.

²³Additional information concerning the evolution of light-wave systems may be found in the books and journal articles referenced in App. B—see in particular, Felix P. Kapron, "The Evolution of Optical Fibers," *Microwave Journal*, April 1985, p. 111.

²⁴Additional historical background on utility use of Interstate freeway ROW may be found in James E. Kirk, *Utility Relocation and Accommodation: A History of Federal Policy Under the Federal-Aid Highway Program; Part II: Utility Accommodation*, U.S. Department of Transportation (FHWA), June 1980.

Table 3
HISTORICAL PERSPECTIVE



II. FRAMEWORK FOR ANALYSIS

Communications by means of any telecommunications system—telephone, computer, video signals, or whatever—requires a basic set of network features. Each user of the network must have *access*—a communications terminal and a connection to the network. For telephone calls the terminal is most often a telephone set and the connection is a pair of copper wires (the “local loop”) running to the local telephone office. In the future, business users may be connected by high-capacity digital fiber-optics cable to the local office.

Once a telephone call reaches the local office, network computers and other equipment are required to supervise, control, and switch the originating user’s message through intermediate points in the network to reach the local office of the called party, and then over another local loop to the destination telephone. In this process the call travels over high-capacity transmission facilities bundled with other calls to be delivered to the same destination.

In each community, local access and metropolitan area communications services are supplied by either Bell Operating Companies (BOCs) or one of the independent telephone companies such as Contel, GTE, or United Telecom. Intercity telecommunications service is provided by AT&T, MCI, U.S. Sprint, and a number of smaller carriers (see Table 4 for relative size and fiber mileage).

The public switched network (PSN) can connect a caller to any other telephone in the network. In the United States the widespread availability of telephones makes this effectively a “universal service.” In addition, private and dedicated networks provide specialized service to governments and larger businesses, enabling their users to communicate by voice and computer to locations that have access to those networks. Private networks often combine user-owned on-premise facilities with intercity facilities supplied by the major commercial carriers.

This study is limited to the backbone network that is required to maintain public switched-network service between major areas in the United States. Local and metropolitan area communications are also vital to national security/emergency preparedness (NSEP), but we exclude them here to concentrate on the basic long-distance routes that are potentially served by Interstate and other highway systems.

Table 4

U.S. LONG-DISTANCE TELECOMMUNICATIONS CARRIERS

Carrier	Market Area	% Market Share	Fiber-Optics Facilities	
			Announced Miles	Cut-Over Miles, ^a Mid-1986
AT&T	National	85	10,200	5,200
MCI	National	8.0	7,000	2,500
U.S. Sprint	National	4.0	23,000	6,200
Fibertrak	National	*b	8,000	0
LDX Net	Regional (NTN) ^c	*b	2,200	600
Mutual Signal	Regional	*b	404	0
Microtel	Regional (NTN)	*b	1,300	731
LiTel	Regional (NTN)	*b	1,600	675
Lightnet	Regional	*b	5,000	700
RCI	Regional	*b	580	0
Southernnet	Regional (NTN)	*b	1,500	331
Southland	Regional (NTN)	*b	330	272
Wiltel	Regional (NTN)	*b	3,500	214
Consolidated Network	Regional (NTN)	*b	730	300
Diginet	Regional	*b	900	550
Electra	Regional	*b	550	550
ICC	Regional	*b	109	0
Bandwidth Technology	Regional	*b	330	100
Indiana Switch	Regional	*b	733	100
Norlight	Regional	*b	550	0

SOURCE: Peach, 1986, pp. 24 and 27.

^aMiles actually operational even if at reduced bit rate.^bTotal of asterisks = 3 percent.^cNTN = National Telecommunications Network.

NETWORK COMPONENTS

A communications network—the capability to connect a group of users—can be thought of in two complementary ways. The *logical* components of the network provide the means of signaling for a connection to another party, establishing the connection, and transmitting the message. These services are ultimately made possible by using *physical* network facilities—a telephone set, copper-wire pair, central office switching machine, and microwave radio, for example. Both the logical and physical network elements are required to maintain communications.

The logical component of the long-distance portion of the public switched network consists of two distinct networks—a message network and a control network. Figure 5 shows a highly simplified representation. The message network provides a continuous channel for voice or data messages from caller to destination for the duration of the call.¹ The route begins at the caller's local telephone office (A) and

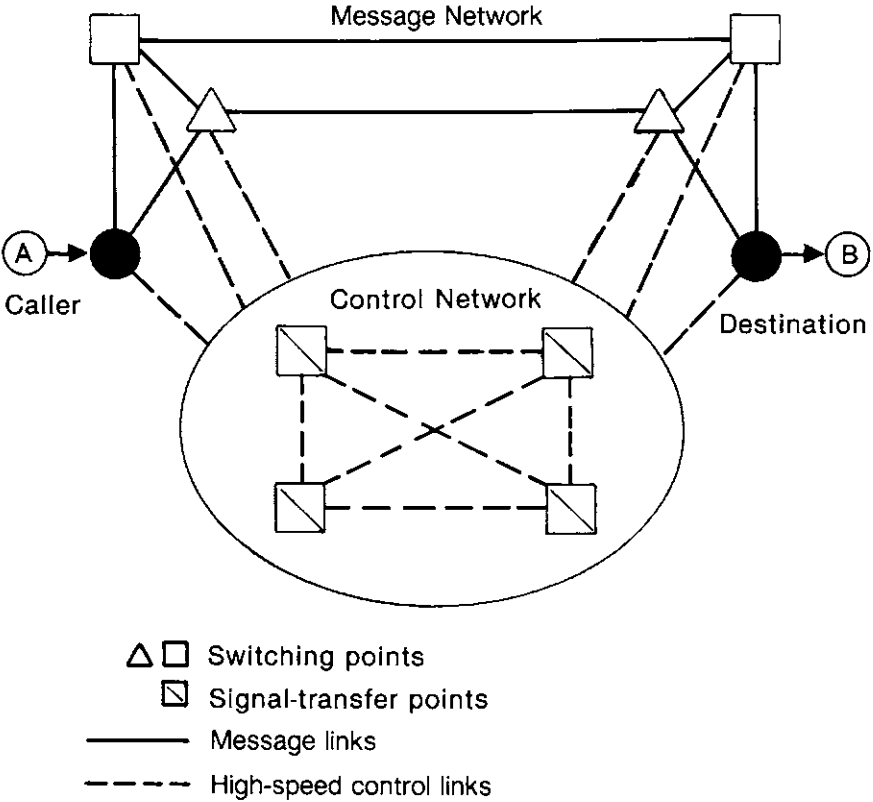


Fig. 5—Message and control networks within long-distance portion of public switched network

¹In an integrated service digital network (ISDN), the caller's message may be divided into small packets that travel over different physical routes at different moments.

usually passes through several intermediate switching points (shown as squares and triangles) before reaching the local office of the destination (B). Typically, any one of several alternate routes (shown by solid lines), perhaps passing through different cities, could be used to complete the call.

The control network determines the particular route the message will travel by employing common-channel signaling (CCS) over separate data lines. In the AT&T system, the control network consists of special-purpose computers located at some 14 signal-transfer points (shown as squares with an inner diagonal) in the United States and Canada. These computers are connected together and to the message switching points by high-speed links (dashed lines). The control points receive dialing information from the originating location, test and establish a message route that will link the caller with his destination, and then ring the telephone and detect the completion of the call.

The signal-transfer points are essential to the operation of the overall network. In the AT&T system, the functions of each control facility are duplicated by a paired, but geographically distant signal-transfer point. If a single control point fails, its pair automatically takes control and messages proceed without interruption. Other inter-exchange carriers (MCI, U.S. Sprint) have a similar division of message and control functions. Each uses some form of common-channel signaling, but with less extensive duplication of control facilities.

RELIABILITY OF MAJOR NETWORKS IN PEACETIME EMERGENCIES

Modern commercial networks have been designed to anticipate a wide variety of hazards, including fire, flood, and loss of electrical power. Under peacetime conditions, the performance of the public switched network (primarily AT&T) has been highly reliable. Operating companies have established emergency procedures and specialized equipment for restoring communications in the wake of natural disasters such as floods, hurricanes, and earthquakes. The other key element of "reliability" in emergency situations has been the availability of alternative routes. Thus, if the primary route is overloaded or damaged, the network's logic can locate and automatically select an alternate transmission path.² Similarly, two locations may be connected by

²An overview of AT&T's latest network control system (termed dynamic, nonhierarchical routing) may be found in John M. Mosenigo and Don M. Tow, "Managing a Network That Won't Stand Still," *AT&T Bell Laboratories Record*, August 1984, p. 23; and Gerald R. Ash and Vernon S. Mummert, "AT&T Carves New Routes in Its Nationwide Network," *AT&T Bell Laboratories Record*, August 1984, p. 18.

both cable and microwave link, potentially allowing calls to travel over different physical facilities to reach the same destination.

THREATS TO COMMUNICATIONS POSED BY NUCLEAR ATTACK

The major risks to the survivability of telecommunications in a nuclear war can be divided into damage to physical facilities and damage to logical networks.

Physical switching and transmission facilities are subject to destruction from blast and fire. But even if the facilities survived the blast and fire effects of a nuclear attack, loss of commercial electrical power would render the system inoperative. In addition to the physical threats, nuclear explosions pose two types of electronic threats. First, an explosion may generate an electromagnetic pulse and cause very rapid surges of high voltages that can damage unprotected electronic components. Second, gamma radiation from explosions can cause fiber-optics cables to "darken," changing their refractive characteristics and causing a loss of signal strength.

The logical components of the control networks are also vulnerable to damage, due to destruction or damage to the centralized control points, damage to the physical facilities over which the control network transmits data, and possible loss of key databases needed to manage the network. A loss of facilities combined with emergency levels of demand for communications could subject the logical network to failure resulting from extreme overloading. In particular, the control network, which is essential to the establishment of message routes and management of alternatives when there is network failure, is highly concentrated in a small number of key signal transfer points. Although the failure of a single installation will not affect network performance, damage to several facilities could potentially terminate message service over wide areas, even where several alternate routes remained intact.

In the future, network control may be less concentrated as systems are designed to meet switching standards proposed for all-digital networks. However, AT&T has recently reduced the number of signal transfer points in the network. In any case, an assessment of the survivability of the control network is beyond the scope of this project. For this study, we assume that the capability of controlling the message network will survive, and investigate the increased survivability of the message network that might be achieved by NSEP-standard fiber-optics links on Interstate highways.

THE POTENTIAL CONTRIBUTION TO NSEP OF A HARDENED FIBER-OPTICS BACKBONE

A hardened nationwide fiber-optics backbone network would provide two benefits for post-nuclear attack communications: (1) increased survivability of the fiber-optics facilities themselves and (2) a greater redundancy of routes over which communications between cities could travel.

Figure 6 illustrates the general nature of these potential benefits. As compared with today's communications network, a hardened Interstate fiber-optics backbone would increase the overall level of network hardness (solid line) and potentially increase the degree of redundancy (dashed line) in the network (to the extent that the Interstate routes supplement rather than substitute for existing or planned non-Interstate routes).

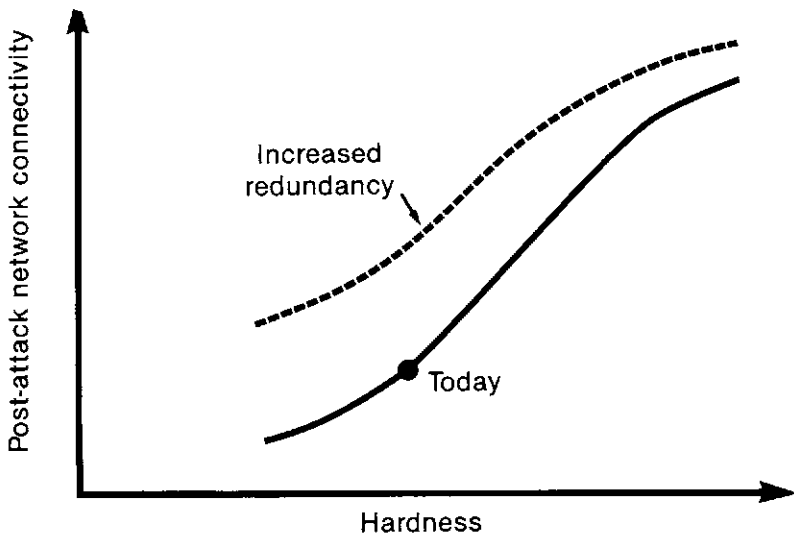


Fig. 6—Potential benefits of a hardened fiber-optics backbone

CONDITIONS NECESSARY FOR OBTAINING A CONTINUOUS HARDENED BACKBONE

Four questions need to be answered affirmatively if the proposed exchange concept is to result in a continuous, hardened fiber-optics backbone:

1. Can complete ROW continuity be obtained for the entire backbone network? (Recall that there are 34 states in our hypothetical backbone.)
2. Can minimum standards of hardness be imposed as a condition of access? And if so, by whom?
3. Is there really a cost advantage on the Interstates (relative to the next best alternative) sufficient to support the cost of enhancements and the ROW payments asked by the states?
4. And finally, even if the other conditions are met, will all segments of the backbone network be financially attractive to the carriers?

The balance of this report addresses these questions, as well as a number of other issues (e.g., potential effects of the proposal on competition in the telecommunications industry and state government considerations in making an Interstate ROW offering). Section III discusses the concerns of highway officials with respect to allowing utilities access to Interstate highway ROW.³ Section IV addresses the possibility of obtaining backbone ROW continuity for the proposed exchange concept and Sec. V then examines the question of whether or not minimum standards of hardness can be imposed as a condition of access. Section VI determines the Interstate highway cost advantage vis-a-vis alternative ROW types. The questions of whether the Interstate cost advantage is indeed sufficient and whether the carriers will be interested in the proposed "access-for-hardness" concept are discussed in Sec. VII. Section VIII summarizes the report's findings. Appendixes A-G present additional detailed information.

³See also App. D.

III. CONCERNS OF HIGHWAY OFFICIALS

The primary concerns of highway officials with respect to the longitudinal occupation of Interstate ROWs by utilities are as follows:

- Safety
- Traffic flow
- Relocation costs
- Liability
- Additional costs to states
 - Administering permits
 - Policing installation and maintenance activities
 - Resolving downstream conflicts

In the balance of this section, we address these concerns and conclude that they should not be a problem with respect to fiber-optics installations. Additionally, we examine what we feel is the real reason underlying the opposition of highway officials to fiber installations on Interstate ROW—the fear of proliferation (that is, if fiber is let on, then all utilities would have to be let on). However, it is our opinion that a valid legal case can be made for limiting access to fiber optics. Overall, we feel that the concerns of highway officials, although they deserve attention, are considerably overstated when applied to fiber optics.

SAFETY AND TRAFFIC FLOW¹

Utilities in General

As shown in Table 5, the Interstate Highway System is the safest of all U.S. road systems. Factors contributing to this safety record include the restriction that no activity is permitted within Interstate ROW unless it directly contributes to the operation of the highway. For this reason, utilities are not permitted to longitudinally occupy Interstate ROW except when unusual or exceptional economic or environmental hardship can be demonstrated. Allowing such access *could* adversely affect traffic flow and safety during utility installation and maintenance operations in the following ways:

¹Most of the material regarding Interstate safety and traffic flow has been provided by Don H. Jones, Assistant Director of the University of Tennessee Transportation Center. His complete paper is provided in App. D.

Table 5
U.S. ACCIDENT AND FATALITY DATA (1983)

Type of Highway System ^a	Total U.S. Mileage (thousands)	Vehicle Miles (billions)	Injury-Producing Accident Rate (per 100 million VMT ^b)	Fatal Accident Rate (per 100 million VMT)
Interstate	43	336	38	1.07
Other arterial	352	733	124	2.51
Collector	807	329	132	3.01
Local	2678	222	240	2.73
Total	3880	1650	122	2.30

SOURCE: *Fatal and Injury Accident Rates on Public Roads in the United States*, December 1983, U.S. Federal Highway Administration.

^aArterials are those routes whose function is to move large numbers of persons and vehicles quickly from one place to another. *Interstates* are a category of arterial. *Collectors* are those routes which gather vehicles from the local roads and streets and funnel them to arterials. *Local* roads and streets provide access to rural resources and farms, as well as to urban businesses and residences.

^bVMT = vehicle miles traveled.

Traffic Flow

- Reduction in speed of vehicular traffic to avoid collisions with slow-moving utility vehicles.
- Reduction in highway capacity as a result of lane closures or increased lateral movements made to steer clear of installation/maintenance activities taking place near the roadway (an object six feet or closer to moving traffic will cause lateral movement of vehicles).

Safety Hazards

- By placing obstacles in the ROW (e.g., slow-moving or stationary vehicles, stockpiled material, and open excavations).²

²We have assumed that utilities located continuously above the ground (aerial power and aerial communication cables) would not be permitted in the ROW on the basis of aesthetics and safety. Furthermore, any above-ground support structures (e.g., electrical substations, pumping facilities, regenerators) required for underground utilities would be located either off the ROW or at the fence line where off-road access could be obtained. Consequently, the utility facilities themselves will not present a hazard for motorists.

- By creating visual impediments (e.g., large vehicles, dust).
- By increasing driver frustration (drivers can quickly become tense and stressed under restricted conditions, leading to an increase in weaving maneuvers and accidents, especially rear-end collisions).

Additionally, Interstate safety could be compromised if utilities transporting volatile or hazardous materials (such as oil or gas pipelines) were permitted within the ROW.

Although few people would disagree with the supposition that utility installations would have a negative effect on Interstate traffic flow and safety, caution must be exercised when attempting to generalize about the magnitude of such effects. For example, if a utility were placed along the fence line in an area with a wide ROW, the effect on traffic flow and safety may be imperceptible. On the other hand, if a utility were placed in a fairly narrow median, the effect on traffic flow and safety could be significant. In short, the magnitude of the effect may vary according to:

- Where in the ROW the utility is to be located (median or fence line) and the proximity of that location to the roadway.
- Whether the Interstate is in a rural, urban, or suburban environment.
- The type of precautionary safety measures employed (e.g., traffic control measures, working hours, weather conditions, and equipment and material storage).
- The type of utility being installed, including:
 - nature of medium being conveyed (e.g., volatility),
 - installation rate and obtrusiveness of construction activities,
 - the amount of Interstate mileage affected, and
 - frequency and duration of maintenance activities.

Lack of appropriate data hinders any effort to assess the effect of utility installation on Interstate safety. Since utilities are not permitted on Interstate ROW (except in a few situations), the data that would be the most germane do not exist (at least in a sample size that would inspire even a minimal level of confidence). A second approach to assessing the effect of utility installation on Interstate safety is by analogy to Interstate road construction and maintenance activities. As the data in Table 6 show, about 4 percent of Interstate fatalities (140/3591) occur in work zones. Unfortunately, the data tell us nothing about:

Table 6


FATAL ACCIDENTS IN INTERSTATE WORK ZONES (1983)

Work Zone	Number of Fatal Accidents
Highway construction	101
Highway maintenance	20
Unknown	19
Total	140
Total Interstate (including work zones)	3591

NOTE: There were no recorded fatalities in utility work zones (as limited as they are) on Interstates in 1983.

Table 7

FATAL ACCIDENTS IN WORK ZONES ON NON-INTERSTATE ROAD SYSTEMS

Work Zone	Type of Road System						Total
	Non-Interstate Freeway/ Expressway	Other Principal Arterial	Minor Arterial	Collector	Local	Unknown	
Highway construction	19	97	70	42	37	2	267
Highway maintenance	5	16	9	9	6	1	46
Utility	0	1	1	4	4	0	10
Unknown	7	28	15	11	7	0	68
Total	31	142	95	66	54	3	391
							
Total fatal accidents		18,423		9,900	6,052	—	34,375
Utility zone fatal accidents as % of total work zone fatal accidents		0.7		6.1	7.4	—	2.6
Utility zone fatal accidents as % of total fatal accidents		0.01		0.04	0.07	—	0.03

- where the work was being done (on-road or off-road);
- what safety precautions were taken;
- the amount of mileage affected;
- the frequency with which work zones occur; and
- the length of time that they exist.

A third approach to assessing the effect of utility installations on Interstate safety is to look at utility-related fatal accidents on other types of road systems. As shown in Table 7, fatal accidents in utility work zones accounted for less than 10 percent of total work zone fatal accidents and less than one-tenth of 1 percent of total fatal accidents. Unfortunately, the data of Table 7 suffer from the same difficulties as the data of Table 6—no information about where in the ROW the work was being done, what safety precautions were taken, frequency, etc. But the data do highlight the point that work zone fatal accidents are a considerably higher percentage of total fatal accidents on Interstates than on other types of road systems:

Road System	Work Zone Fatal Accidents as % of Total Fatal Accidents
Interstate	3.9
Non-Interstate arterial	1.5
Collector	0.7
Local	0.9

To some extent at least, this result is probably attributable to the higher sustained rate of speed on Interstate highways in conjunction with the fact that motorists do not anticipate interruptions on Interstates as they do on other road systems.

In summary, available statistical data are not much help in addressing the issue at hand. From a common sense point of view, it seems inevitable that utility installations on Interstate ROW will have a negative effect on the safety and free movement of vehicles. However, the effect could vary from imperceptible to significant.

Fiber Optics in Particular

Nature of Medium. The issue is whether motorists inadvertently exposed to laser light from optical-fiber cables will suffer eye damage. In normal operation, the answer is clearly no since the cable is buried and no light escapes the individual fibers in any case. During maintenance or repair activities, however, the *potential* for eye damage does

exist, as, for example, in the event of a severed cable. For such damage to occur, one would have to view the severed fiber end through magnifying optics at a distance of less than 10 cm for a sustained period of time.³ Thus, even if a telephone company repairman inadvertently looked into the end of a severed energized optical fiber with his unaided eye, he would not be injured at laser power levels currently in use. Moreover, for a number of reasons, viewing the end of a bundle of fibers is not significantly different from viewing a single fiber.⁴ Consequently, Interstate motorists who might somehow come to view the end of a severed cable (a remote possibility in itself) will not be at risk (at currently used laser power levels).

Installation and Maintenance. It is our opinion that fiber optics installation in *rural* areas would have minimal effect on Interstate highway safety and traffic flow. First, the cable can be installed fairly quickly (six to ten miles per day in the median) and unobtrusively (trenching not required). In fact, a number of fiber installations in toll-road medians (probably the least desirable location in the ROW from a safety perspective) have been accomplished without any major accidents and with little effect on traffic flow. Second, the cable itself requires little, if any, maintenance (the regenerators would be located either off the ROW or with access from off-road). Thus, Interstate traffic should be only minimally exposed to fiber-optics maintenance vehicles.

The overall conclusion reached by RAND's highway consultant on this topic (see App. D) is as follows:

In conclusion, it appears that it is possible to install fiber optic cable in Interstate highway rights-of-way without long periods of *serious* disruption to traffic. Furthermore, based on relatively analogous toll road experience (thruways and turnpikes), the cable can be installed without causing *serious* accidents. . . . [Nevertheless,] it is inevitable that the installation and maintenance of such facilities will, in some way, have an adverse effect on the safety and free movement of vehicles on the highway.

With respect to location on the right-of-way, Jones makes the following observations:

The medians of freeways are the least desirable location for the installation of fiber optic cable. This involves work next to the high speed lanes and equipment must move across traffic to access the

³William T. Ham, Jr., et al., *Ocular Effects of GaAs Lasers and Near Infrared Radiation*, Virginia Commonwealth University, September 1, 1983.

⁴D. L. Philen, R. C. Petersen, A. P. Wakefoose, and J. G. Edwards, "A Look at Safety and Liability in Optical Fiber Communications," *Telephony*, October 13, 1986, p. 54.

installation site. Work in the median may also result in lane closure, due to the proximity of the work to the moving traffic. Installation at the outside edge of the shoulder is the next least desirable location. Although work at the shoulder edge may be done without necessitating a lane closure, it is still in close proximity to moving traffic and interferences can be expected resulting in congestion, reduced capacity during installation and maintenance, backups, delays, and accidents. Under no conditions should the pavement on an Interstate highway be cut, including the paved shoulders, for any such installation.

If fiber optic installations are permitted on Interstate highway rights-of-way, the ideal location would be outside the access control fence which might be accomplished by moving the fence in to accommodate the utility. The next best place for such installations would be between the fence and the slope lines (top of cuts and toe of fills). . . .

RELOCATION COSTS

Background

Historically, it has been in the public interest for public utility facilities to use the rights-of-way of public roads and streets, usually at no cost. However, it is frequently the case that in order for highway improvement projects to proceed, existing utility facilities must be removed and relocated.⁵ Utilities would obviously like to see such relocation expenses reimbursed. However, the general rule is that in the absence of specific statutory authority, the utility must bear its own cost when required to relocate to accommodate improvements. But in many states,

. . . statutes have been enacted that authorize the highway agency to pay relocation cost on certain types of highways, usually Interstate and other federal-aid primary and secondary highway projects. Most of these State statutes were enacted in order to take advantage of 23

⁵The background discussion on relocation costs has been summarized from the following documents:

- Larry W. Thomas, "Payments to Public Utilities for Relocation of Facilities in Highway Rights-of-Way," *Research Results Digest*, Transportation Research Board of the National Research Council, February 1980.
- James E. Kirk, *Utility Relocation and Accommodation: A History of Federal Policy Under the Federal-Aid Highway Program; Part I: Utility Relocation*, Department of Transportation (FHWA), June 1980.

U.S.C. 123, which authorizes FHWA to reimburse States on a *pro rata* basis⁶ for utility relocation cost as part of the highway construction contract. The State reimbursement statutes were necessary because Section 123 does not permit reimbursement if such payments violate State law. Moreover, the regulations provide that reimbursement is made only where there is a State law that provides a "suitable" basis for reimbursement.⁷

Table 8 provides a simplified summary of state statutes as of 1980 (see footnote a to the table). As indicated, 21 states (15 "all-Interstate" and six "all Federal-aid highways") have authority to reimburse relocation costs on all types of Interstate highways while another three states have authority to reimburse on Interstate highways in urban areas. Statutory authority clearly does not exist in 11 states and apparently does not exist with respect to Interstate highways in another 13.

Concern of Some States

If longitudinal occupancy of Interstate highways by utilities were permitted, future highway improvement projects might necessitate utility relocation. In *some* states this means that state highway departments would incur additional expenses for utility relocation payments—on the order of 10 percent of total relocation costs. The magnitude of such costs will, of course, depend on whether or not a utility has to be relocated, which in turn will depend on its location in the ROW and the nature of future Interstate highway improvement projects. Moreover, if the utility were to otherwise be located on a non-Interstate federal-aid highway, the state's additional costs could be even greater since the federal share on such highways is only 75 percent.

Viewpoint of One Utility Company Manager

It is interesting to contrast the state concern expressed above with the viewpoint of a manager working for a California-based utility:

. . . [The company I work for is currently] faced with three major relocations of freeway-based systems that are less than five years old. These relocations will substantially reduce the economic justification for the initial use of the involved public roads. Furthermore, a

⁶Federal funds may be used to reimburse the state for relocation costs in the same proportion as federal funds are expended on the overall project. The federal share on the Interstate program is 90 percent. (Footnote added.)

⁷Thomas, 1980, p. 13.

Table 8

STATUTORY AUTHORITY RELATING TO REIMBURSEMENT OF
PUBLIC UTILITY RELOCATION EXPENSE^a

State	All Interstate	Urban Interstate Only	All Federal-Aid Highways	Controlled- Access Highways	State Highways	No Statutory Authority Located
Alabama						
Alaska						
Arizona						
Arkansas						
California						
Colorado						
Connecticut						
Delaware						
Florida						
Georgia						
Hawaii						
Idaho						
Illinois						
Indiana						
Iowa						
Kansas						
Kentucky						
Louisiana						
Maine						
Maryland						
Massachusetts						
Michigan						
Minnesota						
Mississippi						
Missouri						
Montana						
Nebraska						
Nevada						

Table 8 (continued)

State	All Interstate	Urban Interstate Only	All Federal-Aid Highways	Controlled- Access Highways	State Highways	No Statutory Authority Located
New Hampshire						
New Jersey						
New Mexico						
New York						
North Carolina						
North Dakota						
Ohio						
Oklahoma						
Oregon						
Pennsylvania						
Rhode Island						
South Carolina						
South Dakota						
Tennessee						
Texas						
Utah						
Vermont						
Virginia						
Washington						
West Virginia						
Wisconsin						
Wyoming						
Total count	15	3	6	2	13	11

SOURCE: Thomas, 1980, pp. 14-16.

*Reference must be made to specific state statutes for important exceptions, limitations, or requirements. For example, although the table indicates that some authority exists for reimbursement for utilities located on state highways, the provision may apply only to facilities owned by municipalities or public service companies, or may include privately owned utilities. The provision may be limited to state freeways or parkways, include all limited access highways, or all state highways. In some instances, a reimbursement provision clearly includes all federal-aid highways and state highways. In sum, the reader is cautioned to consult specific statutes and any amendments.

review of court cases and recent legislative history will reveal that the trend in utility relocations is for all relocation costs to be borne by the public utility. For example, historically, we have relocated at our cost when required to do so for roadway purposes. Today, utilities are relocating for traffic control devices, storm drains, sewers, wheel chair ramps, bike trails, redevelopment areas, and light rail systems. These relocations are in addition to those required by tariffs administered by Public Utility Commissions. A recent five year estimate of these costs for California exceeds \$100,000,000. In fact, a prevailing school of legal thought expects that all utilities will be relocating whenever and wherever requested to do so at their cost by any government jurisdiction.

The best location for utility facilities is on private property. Given the total cost of most utility facilities, private property right-of-way costs should not have a significant effect on a project's economic viability. A private property easement properly acquired gives the company a primary property right with access available at *all* times. Furthermore, all relocations are the responsibility of a party other than the owner of the facilities.

Summary of State Concern with Relocation Costs

As things now stand, some states may incur additional expenses for utility relocation payments (but only 10 percent of the total relocation cost) while other states will not. The relative importance of this state-held concern is highly uncertain, however, due to the uncertain nature of the utility location within the ROW, the total number of utilities within the ROW, and the scope of future Interstate highway improvement projects. Nevertheless, all states have the power to potentially contract for payment of relocation costs by the utility.⁸

LIABILITY

Liability issues with respect to underground utilities are not new. The concerns of state highway department officials with respect to utility installations on Interstate ROW are similar to those of any contractor working around buried utilities on any type of ROW: If a utility is accidentally damaged in the course of construction or maintenance activity, who will be liable for the costs of repairing the break? The loss of revenue? Any consequential damages (losses incurred by utility customers as a result of loss of service)?

What is new, however, is the perception that the potential magnitude of liability associated with fiber-optics cables is greater than with

⁸An example of such a provision is provided in App. E, Article I, Section 3C.

conventional cable types. It is alleged that they are more easily damaged, take longer to repair, and will result in a greater loss of revenue if severed because of their larger capacity.⁹ Not too surprisingly, the communications companies take exception:

High capacity metallic cable systems have been in service for the past 20 years. Some of these coaxial cable systems have more circuit capacity than some of the optical fiber systems that exist today. In fact, coaxial cables are more susceptible to construction type damage than optical fiber cables. There is no indication that an optical fiber cable is more susceptible to damage than any other type of cable.¹⁰

Lawsuits based solely on loss of service have never been very successful, simply because the actual loss is so difficult to document and prove. Thus, optical fiber cables do not represent any increased risk over systems already in use. In terms of service restoration times, optical fiber cables can be put back in service faster than conventional copper cables carrying the same volume of traffic.¹¹

Thus, it would appear that liability concerns would not be any greater for optical cable than for conventional cable.

Some highway officials have also expressed concern that a severed cable on an Interstate ROW could lead to the cutting off of vital medical, police, and fire services. In a local or intra-urban context this is clearly a valid concern. However, in the *long-haul, intercity* context of this study, there is typically sufficient redundancy in the network to neutralize the issue.

Finally, all states have the power to potentially incorporate "hold harmless" clauses into ROW use agreements with communications companies.¹² Such clauses would generally protect state highway departments against all but negligent actions.

⁹Letter from Gerard Kenney, President, National Utility Contractors Association, to Ray Barnhart, Administrator, FHWA, dated July 18, 1986.

¹⁰Optical cable sheath designs are in some cases far more rugged than conventional cable, i.e., double sheath, double armor. The inference that optical cable is fragile because of glass fibers is misleading. A better line of reasoning would be: because the fibers are glass, the sheath designs are rugged. (Footnote added; personal communication from Bill Eliot of BellCore.)

¹¹Philen, 1986, p. 56.

¹²An example of such a provision is provided in App. E, Article IV, Sec. 4.

ADDITIONAL COSTS TO STATES

Utility use of Interstate ROWs would undoubtedly create additional costs for state highway authorities in terms of administering permits, policing installation and maintenance, and resolving downstream conflicts. Conceptually, the magnitude of these administrative-type costs could be expected to vary with such factors as:

- location in ROW (fence line or median and if median, the width);
- total number of utilities in the ROW;
- the definition of “reimbursable” expenses; and,
- the nature of future highway improvement projects.

We were able to identify only two relevant data points with respect to administrative-type costs. First, the State of Georgia has set the following rates for utility use of its highway ROW:¹³

Urban area:	\$5000 per mile per year
Rural area:	\$2000 per mile per year (> 2000 cars per day)
	\$1000 per mile per year (< 2000 cars per day)

Second, one firm has indicated that the initial reimbursable expenses associated with their use of a fairly short stretch of toll road (at the fence line) ran between \$1000 and \$1500 per mile. Additionally, there have not been any recurring reimbursable expenses nor does the firm expect there to be any.

Thus, the observed values, when placed on a comparable basis, differ by roughly an order of magnitude:

	<u>One-time Charge</u>
Toll road	\$1000–1500 per mile
Rural Georgia highway (high volume)	\$12,500 per mile ¹⁴

We are unable to explain the differences. However, it is hard to imagine a state voluntarily agreeing to a fee that did not at least cover

¹³According to FHWA personnel, the basis for these rates was a recent study that assessed the cost to the Georgia Department of Transportation of conflict resolution (see App. F).

¹⁴Present value of 20 year stream at 15 percent per year.

the expected increase in administrative-type costs unless there were other nonquantifiable benefits whose perceived value outweighed such costs. Moreover, we have observed one toll-road contract where the carrier was required to pay not only a fee for the grant of easement but also to reimburse the toll-road authority for all expenses incurred due to the grant.¹⁵

PROLIFERATION

When taken in the context of the full spectrum of possible utility installations, the concerns of highway officials clearly have merit. However, with respect to the specific case of fiber-optics installations, we feel that the concerns are of relatively little, if any, significance. Based on reasonably analogous toll-road experience, we see no reason that the relocation and administrative cost issues as well as most liability questions cannot be handled by contractual means. Additionally, it is our opinion that fiber-optics installations in *rural* areas would have minimal effect on Interstate safety and traffic flow.

So, given the minimal effect on safety and traffic flow that fiber installations are likely to have, why are highway officials so opposed? Some have had bad experiences with utilities in the past (i.e., not following agreed-upon installation procedures) and simply do not trust any of them. But it is our opinion that the bulk of the opposition results from the fact that highway officials view fiber optics as a Trojan horse—if fiber is let on, then all utilities will have to be let on, and then the safety, traffic flow, and administrative headaches will really start.

The question now becomes one of whether access can be limited to fiber optics. As a matter of law, discrimination among utilities for access to a government benefit requires a “rational basis” (Equal Protection Clause of Constitution).¹⁶ But the methodology by which courts look for such a rational basis is remarkably generous to the government decisionmaker. Here is language from the Supreme Court’s opinion in *New Orleans v. Dukes*, 427 U.S. 297 (1976):

When . . . economic regulation is challenged solely as violating the Equal Protection Clause, this Court consistently defers to legislative determinations as to the desirability of particular statutory discriminations States are accorded wide latitude in the regulations of their local economies under their police powers, and rational distinctions may be made with substantially less than mathematical

¹⁵See App. E, Article I, Sec. 2B and Article II, Sec. 3B(2).

¹⁶U.S. Constitution, Fourteenth Amendment, Sec. 1.

exactitude. Legislatures may implement their program step by step in such economic areas, adopting regulations that only partially ameliorate a perceived evil and deferring complete elimination of the evil to future regulations In short, the judiciary may not sit as a superlegislature to judge the wisdom or desirability of legislative policy determinations made in areas that neither affect fundamental rights nor proceed along suspect lines; in the local economic sphere, it is only the invidious discrimination, the wholly arbitrary act, which cannot stand consistently with the [Equal Protection Clause].

Generally speaking, so long as fiber-optics utilities have *any* advantage over other utilities with respect to *any* single criterion—or any combination of criteria—then a policy that limits access to hardened fiber optics would not be held to violate Equal Protection. Moreover, even if fiber-optics utilities were exactly identical to every other utility for access purposes, the “step by step” or “one step at a time” doctrine in Equal Protection law would probably enable government to single out fiber-optics utilities for favored treatment.

We have heard several suggestions on how fiber-optics utilities might be distinguished from other utilities. *National security* is one possibility, but a number of utilities can make claims to their national security necessity, including oil and natural gas transmission pipelines and power transmission cables. *Safety* appears to be a more viable concept. Utilities that transport a volatile or hazardous medium (such as oil and gas pipelines and power transmission cables) might be excluded, as well as utilities which, if ruptured, could undermine the stability of the roadway (water, sewer). Additionally, compared with other utility types, fiber-optics *installation* is relatively fast and unobtrusive and *maintenance* requirements are minimal.

In summary, while we cannot state with absolute certainty what the ultimate outcome of possible judicial challenge to such line-drawing would be, we nevertheless believe a strong case can be made for limiting access to Interstate ROW to fiber optics. Conceivably, such distinctions could be made administratively or legislatively, at the federal or state level. In this regard, it is important to note that any such line-drawing undertaken by a federal agency such as the FHWA could be challenged in federal court on grounds that it is “arbitrary and capricious” (5 U.S.C. 706). To show that its action can escape this challenge, FHWA would need to prove that it has given a “hard look” to the entire problem and fair consideration to all relevant alternatives.

In short, the special requirements for federal administrative action are considerably more stringent than the general requirements for legislative action. From a practical perspective, therefore, the fiber-optics-only policy would be easier to justify in court if it were adopted by Congress itself, rather than adopted by the FHWA pursuant to a

congressional delegation. In this regard, observe that relevant Committees in both the House and Senate have expressed their sympathy for a change in policy that might grant Interstate access to fiber-optics systems.¹⁷ This expression of sympathy might suggest that congressional approval could be secured.¹⁸

¹⁷See App. C, Items 11 and 12.

¹⁸In addition, these Committee expressions of congressional understanding might make it easier for the FHWA to defend any regulation it might issue against the accusation that the regulation is "arbitrary or capricious." To this extent, the practical problem referred to above is reduced.

IV. ESTABLISHMENT OF RIGHT-OF-WAY CONTINUITY

Because of the shared federal-state responsibility for the Interstate Highway System, the proposed development of a hardened fiber-optics backbone on Interstate rights-of-way raises a complex of legal and institutional issues. In this section, we examine the legal and political feasibility of obtaining access to all Interstate rights-of-way required for a backbone network. Three generic approaches were considered:

- Pursuing *voluntary* federal/state cooperation;
- *Inducing* state cooperation by tying federal highway aid to a state's granting of access; and
- *Compelling* state cooperation either through: (a) the Congressional power of eminent domain; (b) certain authorities granted by Congress to specific agencies within the Executive Branch (FHWA, Federal Emergency Management Agency (FEMA), and NCS); or (c) Presidential war and emergency powers.

It should be kept in mind that the statutes and regulations discussed herein were enacted to promote highway purposes, such as safety and traffic flow. The lawmakers were not thinking about the possibility that the federal government might eventually want to promote some other use of the rights-of-way. Thus, our legal conclusions are based on interpretations for which there is little precedent and are, therefore, necessarily speculative to some extent.

VOLUNTARY FEDERAL/STATE COOPERATION

For the voluntary federal/state approach to work, two things must happen. First, the FHWA must modify its current Interstate utility accommodation policy. Second, the individual states, which actually own the Interstate ROW, must agree to grant access. In the following paragraphs, the prospects for each are discussed.

Prospects for FHWA Policy Change

Existing Policy. At this time, both federal and state policy severely constrain longitudinal access to Interstate highway rights-of-way by utilities. The federal policy is set forth in FHWA regulations¹ that incorporate a policy first developed in 1959 (revised in 1982) by the American Association of State Highway Transportation Officials (AASHTO). State utility accommodation policies for federal aid highways are subject to approval by the FHWA under 23 CFR 645.215. Therefore, they are no less restrictive than the federal policy.²

The AASHTO policy was developed in the context of the 1956 Federal Aid Highway Act which required that geometric and construction standards be adopted for the Interstate system.³ AASHTO standards adopted by the FHWA in 1959 provided for full control of access on all sections of the Interstate system. Access control was recognized as the significant design factor in contributing to both freeway system safety and preserving traffic-carrying capacity. Highway officials also recognized that control of access could be materially affected by the extent and manner in which utilities were permitted to cross or otherwise occupy the right-of-way of Interstate highways. It was agreed that to be able to effectively carry out the intent of the highway legislation, a uniform national policy should be developed to establish the conditions under which public and private utilities could be accommodated on Interstate right-of-way.

In 1959 AASHTO issued its document, *A Policy on the Accommodation of Utilities on the National System of Interstate and Defense Highways*⁴ and the FHWA accepted it as a design standard for Interstate projects.

The primary objectives of the AASHTO policy are to

¹23 CFR 645.209(c), "Installations within freeways." See App. C, Item 2, for complete text of 23 CFR 645, Subpart B (i.e., 23 CFR 645.2XX).

²For implementations of state policies, see, for example, *Manual of Policy, Procedure, Rule and Regulations for Use in Issuing Encroachment Permits in State Highways in California*, State of California Business and Transportation Agency, Department of Transportation, Sacramento, California; *Policies for the Accommodation of Utilities*, Bureau of Utilities and Properties, Ohio Department of Transportation, Columbus, Ohio; *Regulations and Policy Governing Occupancy of State Highway System Right-of-Way by Public Utility Facilities*, State Department of Highways, Division of Highways, Denver, Colorado; *Rules and Regulations Governing the Accommodation of Utilities within the State Highway Right-of-Way*, Department of Transportation, Albany, New York.

³23 U.S.C. 109 (see App. C, Item 14).

⁴As revised in 1982, the policy is now entitled, *A Policy on the Accommodation of Utilities Within Freeway Right-of-Way*. Hereinafter, it will be referred to simply as the *AASHTO Policy* (see App. C, Item 1).

- Develop and maintain access control,
- Increase highway safety and function to the maximum, and
- Ensure uniformity of utility treatment by the states.

The policy does recognize the need to allow installations to cross over or under the right-of-way in recognition of the public interest in avoiding unnecessary and costly operation of public utility functions.

In general, the policy prohibits longitudinal installation of new utilities within the access control lines, except for "hardship" exceptions.⁵ Such a case requires a showing that *all* of the following conditions are met:

- The accommodation will not adversely affect the safety, design, construction, operation, maintenance, or stability of the freeway;
- The accommodation will not be constructed and/or serviced by direct access from the through traffic roadways or connecting ramps;
- The accommodation will not interfere with or impair the present use or future expansion of the freeway; and,
- Any alternative location would be contrary to the public interest. This determination would include an evaluation of the direct and indirect environmental and economic effects which would result from the disapproval of the use of such right-of-way for the accommodation of such utility.

A recent expansion of federal utility accommodation policy permits an additional class of exceptions to mitigate damage to agricultural lands.⁶ Similar conditions must be met:

- There must be adequate right-of-way available which is not needed for planned highway expansion;
- Such use does not adversely affect highway safety or highway operations or otherwise impair the highway, its aesthetic quality, or its maintenance; and
- It can be shown that the installation on the freeway right-of-way is the most feasible and prudent location available.

The policy followed today remains much as it was at the outset of the Interstate system in 1956. Stringent application of the requirement that utility use not "adversely affect" safety has limited the number of exceptions granted.⁷ Since 1960 the FHWA estimates that nationwide

⁵AASHTO Policy, p. 3.; 23 CFR 645.209(c).

⁶23 U.S.C. 109(l)(1)(B).

⁷23 CFR 645.209(c).

it has approved approximately 250 requests to allow longitudinal utility use. During this same period, the FHWA formally denied approximately 150 requests for longitudinal access.⁸ The number of formal denials by the FHWA understates the number of requests for access, since in most cases state highway agencies deny a utility's request and the matter does not reach the FHWA. Exceptions that have been granted are generally limited to short stretches (less than a mile) in urban areas where right-of-way is scarce and expensive. The majority of these exceptions are for underground utilities, such as gas, water, sewers, and communications.

Table 9 summarizes special case exceptions granted from January 1983 to May 1986. In total, 53 exceptions were approved, a rate higher than historic averages. Note that both Interstate and non-Interstate freeway exceptions are included.

Although longitudinal access continues to be severely restricted, crossings of the right-of-way are permitted subject to considerations of safety, aesthetics, and difficulty of highway maintenance. The utility must meet construction standards and take measures necessary to protect traffic and its safe operation⁹ during installation and subsequent maintenance. Specific approval and terms must be included in the use and occupancy agreements issued by the state highway agency.¹⁰ The state highway agency is not required to submit utility requests for use of federal-aid highway right-of-way to the FHWA except in the case of longitudinal installations involving the special case exceptions under the AASHTO policy and 23 CFR 645.209(c), as described above. In these "hardship" cases, the state highway agency may deny the application; the utility has no recourse or appeal as a matter of right. Where the state agency contemplates approval of an application, it must submit it to the FHWA for prior concurrence.¹¹

Initiation of Policy Review. Communication companies, as well as other utilities, have long sought access to Interstate ROW—initial installation is relatively inexpensive and simply having the potential for access would provide an additional intercity route alternative.¹² In

⁸Informal communication from J. Overton, Railroads and Utilities Branch, FHWA, July 22, 1986.

⁹See AASHTO publications, *A Guide for Accommodating Utilities Within Highway Right-of-Way*, 1981 and *Guide for Selecting, Locating and Designing Traffic Barriers*, 1977.

¹⁰23 CFR 645.213.

¹¹23 CFR 645.215(d)(2). Note that longitudinal use of right-of-way by *private* lines is handled under the provisions of 23 CFR 1.23(c).

¹²However, this does not mean that the carriers are unanimous in their opinion, for they are not. For example, Pacific Bell professes little interest because they feel that even though the Interstates may have an initial cost advantage, that in the long run, Interstate costs will be greater than privately owned alternatives.

Table 9

LONGITUDINAL USE OF FREEWAY RIGHTS-OF-WAY: FHWA
APPROVED SPECIAL CASE EXCEPTIONS, 1983-1986

State	Date Approved	Utility Type	Length on Freeway (miles)
California	1983	Underground pipeline	0.17
California	1983	Power cable on bridge	0.11
California	1984	Underground sanitary sewer	0.29
California	1984	Telephone cable on bridge	0.15
California	1984	Underground telephone	4.0
California	1984	Underground water	0.02
California	1984	Underground water	0.42
California	1984	Underground pipeline	0.19
California	1984	Underground pipeline	0.19
California	1984	Ducts on bridge	0.04
California	1984	Underground telephone	0.14
California	1984	Overhead power	0.11
California	1986	Sanitary sewer on bridge	0.22
California	1986	Underground water	0.28
Colorado	1984	Overhead power	10.0
Illinois	1986	Underground storm sewer	0.11
Louisiana	1984	Antenna on bridge	(spot location)
Louisiana	1985	Ducts on bridge	0.72
Minnesota	1986	Underground storm sewer	1.14
North Dakota	1983	Underground water	1.0
New Mexico	1984	Underground telephone	0.03
Nevada	1983	Underground water	0.04
New York	1986	Overhead TV cable	0.68
Ohio	1985	Underground water	0.97
Pennsylvania	1985	Underground sanitary sewer	0.76
South Dakota	1984	Underground water	1.6
Texas	1983	Overhead power	(through interchange)
Texas	1983	Underground gas	0.54
Texas	1983	Underground telephone	0.09
Texas	1983	Underground gas	(through interchange)
Texas	1983	Overhead power	(through interchange)
Texas	1983	Underground sanitary sewer	0.13
Texas	1983	Overhead TV cable	0.19
Texas	1983	Underground telephone	0.09
Texas	1984	Underground gas	0.08
Texas	1984	Underground water	0.09
Texas	1984	Underground sanitary sewer	0.05
Texas	1984	Overhead power	0.13
Texas	1984	Underground sanitary sewer	0.09
Texas	1984	Underground sanitary sewer	0.09
Texas	1984	Underground gas	0.15
Texas	1985	Underground gas	0.08

Table 9 (continued)

State	Date Approved	Utility Type	Length on Freeway (miles)
Vermont	1985	Overhead power	0.45
Washington	1983	Underground power	0.04
Washington	1983	Underground storm sewer	0.03
Washington	1983	Underground telephone	0.18
Washington	1984	Underground sanitary sewer	0.03
Washington	1984	Underground water	0.34
Washington	1984	Underground water and sewer	0.42
Washington	1985	Overhead power	0.46
Washington	1985	Underground water	0.05
Washington	1985	Underground telephone	0.11
Washington	1986	Underground telephone	0.23

the latter stages of 1985, the carriers were joined in this objective by the governor of New York. The Governor believed that updating New York's telecommunications infrastructure using fiber optics was a good way to promote economic development. He also believed that a particularly inexpensive way to install fiber-optics cables was by using Interstate highway ROW. Consequently, in January of 1986, the Governor wrote the Secretary of Transportation urging that the federal policy prohibiting utility use of Interstate ROWs be revised.

Concomitantly, the New York congressional delegation began to take an interest in this issue. Public hearings were held and, eventually, recommendations were made to the Secretary of Transportation. Both the House Committee on Public Works and Transportation and the Senate Committee on Environment and Public Works, in their reports to the full House and Senate on the Federal-Aid Highway Act of 1986, urged the Secretary to carefully consider the possibility of granting fiber optics access to Interstate ROW. However, both committees, sensitive to the concerns of highway officials, considered unlimited access (i.e., granting access to all utility types) undesirable:¹³

¹³It should also be noted that neither the congressional expressions of interest nor the public statements made by the governor of New York recognize the national security possibilities suggested by the NCS proposal. To this time, both groups have justified the granting of access solely on the basis of economic development.

*While the Committee remains opposed to unlimited access to Interstate rights-of-way by every utility [italics added], it appears that a great deal can be gained by accommodating fiber optic cables with little appreciable negative effect on traffic or safety.*¹⁴

*While unlimited access to Interstate rights-of-way by every utility is not desirable [italics added], it appears that benefits might be able to be obtained by accommodating fiber optic cables without a negative effect on traffic or safety.*¹⁵

Consequently, given this greatly increased level of interest on the part of the governor of New York and the Congress, it is not too surprising that on April 1, 1986, a notice was published in the *Federal Register* (51 FR 11055) advising the public that the FHWA was "reviewing its existing policy governing utility use of Interstate (freeway) right-of-way (23 CFR 645, Subpart B) to determine if changes or modifications in this policy are needed."

Current Status of Policy Review. On December 19, 1986, the FHWA published a notice of proposed rulemaking in the *Federal Register* (51 FR 45479). The actual text of the proposed changes to Sections 645.209 and 645.211 may be found in Item 15 in App. C. Below we summarize the proposed changes (including statements of intent) and then assess their potential effect on the access-for-hardening concept:

Summary of Proposed Changes.

- **Conditions of Access:** Section 645.209(c) of the proposed rule is modified to clarify the conditions required to obtain approval for longitudinal installations within freeways. Item 2 of the 1982 AASHTO policy is no longer incorporated by reference. Instead those sections of Item 2 that FHWA wishes to incorporate appear in full in the rule.

In summary, the FHWA is proposing that two major conditions be applied to approval of installations within freeway access control lines:

1. Is the installation warranted because alternative locations are:

¹⁴"Federal Highway Act of 1986," *Report of the Committee on Public Works and Transportation*, United States House of Representatives, 99th Congress, 2d session, Report 99-665, July 2, 1986, p. 3.

¹⁵"Federal Highway Act of 1986," *Report of the Committee on Environment and Public Works*, United States Senate, 99th Congress, 2d session, Report 99-369, August 4, 1986, p. 5.

- a. Unreasonably costly, or
 - b. Extremely difficult to implement, or
 - c. Adversely impacting agricultural lands? and
2. Is the installation safe and does it not adversely affect the operation of the freeway?

From a practical standpoint, this is no different from the current policy. However, what is different, and what does not appear in the revised rule per se, is the FHWA's *intent* to expand the scope of what costs may be considered in the determination of "unreasonably costly." Currently, such determinations are limited to the cost impact on the utility consumer. Under the proposed rule, however, costs not only to the utility consumer but also to the utility company and highway agency could be considered.¹⁶

It should also be noted that, as is the case with the existing rule, there is nothing in the proposed rule to prohibit a state from adopting a more restrictive policy than that advanced by the FHWA.

- State-administered class-approval procedures: It is the FHWA's view that not all utilities would have an equal effect on safety. For example, of the two broad classes, above ground and below ground, underground utility facilities which require little maintenance or servicing would obviously have less impact than above-ground utility installations which are more subject to environmental deterioration and may create a safety hazard as a roadside obstacle. As a result of this consideration, the FHWA proposes to permit states to develop and administer so-called class-approval procedures (i.e., specific terms and conditions that the various utility classes would have to satisfy¹⁷ in

¹⁶As of October 1987, a proposed *final* rule had been approved by the FHWA but was still awaiting the approvals of the Secretary of Transportation and OMB. Consequently, it has not yet been promulgated and is therefore still subject to change. However, the FHWA has informed us of one fairly significant change to the earlier version of the rule: the addition of "benefit to the government" as a consideration in the granting of access.

¹⁷In setting the terms and conditions that would apply to each class of utility, the FHWA would require that states carefully consider the following factors:

- The utility's effect on the safety and operations of the highway.
- The extent of interference with highway maintenance activities that the installation may impose.
- The possible conflict with future planned highway uses that the particular utility may impose.

order to meet the more general FHWA conditions of access). This class-approval process would be implemented at a state's option in its utilities accommodation plan. Once the plan is approved by FHWA, applications for longitudinal installation, which under current policy must be approved by FHWA, will no longer require such approval.¹⁸ Thus, it is apparent that this change could serve to expedite the approval process.

- **Location in ROW:** In any case where utility use of freeway right-of-way is permitted, the FHWA believes the facilities should be placed as far from the travel lanes as possible, preferably along the right-of-way line.

Implications. The potential effects of the proposed final rule on the access-for-hardening concept are mixed. On one hand, it could be of considerable help because: (a) it defines a broader context for the consideration of costs and (b) it specifically references the concept of government benefit. On the other hand, it could be of considerable detriment to the concept because: (a) it rules out the most favorable location within the ROW from the standpoint of installation cost (i.e., the median) and (b) it does not prohibit states from adopting more restrictive conditions for access (potentially, thereby, frustrating ROW continuity for a full backbone network).

Prospects for State Cooperation

Legal Issues. Even if the federal government were to ease its restriction on longitudinal utility access to Interstate rights-of-way, the final decision on whether to grant access would reside with the states that own the ROW. Consequently, we reviewed statutes in 21 states to determine the extent of possible legislative restrictions. The sample of 21 states (see Table 10) was selected on the following basis:

- Inclusion of all states indicating in an AASHTO survey that legislation either would or might be required to accommodate communication cables on Interstate and freeway right-of-way;¹⁹
- Adverse effects on highway users, such as visual distractions or impediments, imposed by the installation.
- The possible physical impairment to the highway facility.

¹⁸In those instances where the state does not choose to adopt the class-approval process, longitudinal installation applications will require FHWA approval.

¹⁹Based on responses to question 12 of the AASHTO Fiber Optics Task Force Questionnaire (see App. C, Item 4). Of the 42 respondent state highway officials, ten states stated that enabling legislation would be required to implement an AASHTO policy change to accommodate communication cables on Interstate right-of-way. Two others were unsure. The AASHTO questionnaire will be discussed in more detail subsequently.

Table 10
STATE SURVEY SAMPLE

State	Potential Legislation Required ^a	Potential Involvement in NORAD-to- SAC Link	Turnpike State ^b	Existing Fiber- Optics Installation on Turnpike ^c	Other
Alaska					
California					
Colorado					
Connecticut					
Florida					
Georgia					
Illinois					
Kansas					
Maine					
Maryland					
Missouri					
Montana					
Nebraska					
New Hampshire					
New York					
Ohio					
Oklahoma					
Oregon					
Pennsylvania					
Tennessee					
Wyoming					

^aStates indicating (as part of AASHTO survey) that legislation might be required to accommodate communication cables on Interstate and freeway right-of-way.

^bOther turnpike states include Delaware, Indiana, Iowa, Kentucky, Massachusetts, Michigan, New Jersey, Texas, Virginia, and West Virginia.

^cOther states with fiber-optics installations on their turnpikes are Indiana and Massachusetts.

- Inclusion of all states potentially involved in a NORAD-to-SAC defense link;
- A sampling of turnpike (i.e., toll-road) states,²⁰ including some that have permitted fiber-optics installations along such routes; and,
- One state (Oregon) that applied to install a state owned and operated fiber-optics system along an Interstate route but was denied by the FHWA.

As illustrated in Fig. 7, the sample provides reasonable coverage from the standpoint of geographical dispersion.

State Statutes on Access. At the initiation of this study, the conventional wisdom was that at least some states prohibited utility access to

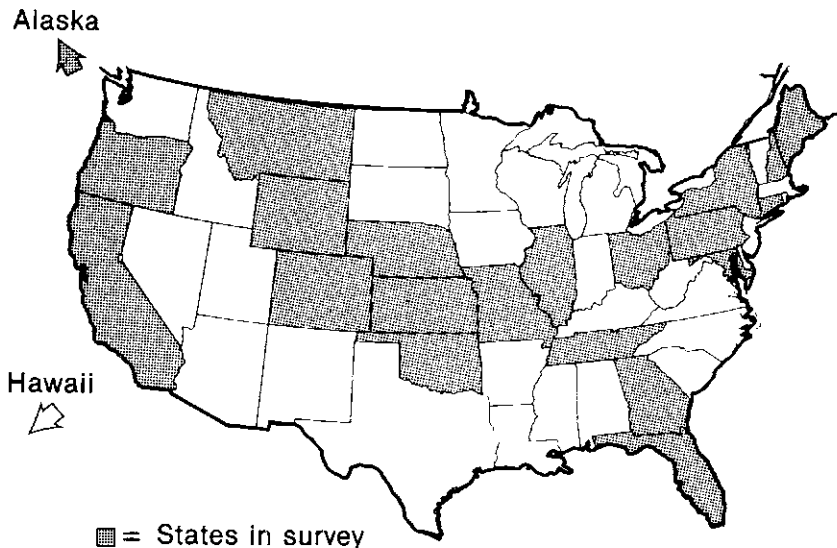


Fig. 7—State highway law survey

²⁰Turnpikes are controlled-access highways administered independently of other state highways. In general, no federal funds are used for the construction or maintenance of such freeways. They are usually financed by the sale of state bonds. Although they may be designated as components of the Interstate system, FHWA practice permits turnpike authorities to make their own rules concerning utility access.

freeways by law.²¹ Somewhat surprisingly, we were unable to identify any statute in any one of the 21 sample states that prohibited utility access to freeway rights-of-way. On the contrary, in every state surveyed, the statutes reflected the policy that longitudinal accommodation of utilities along highway rights-of-way is a desirable use of public roads. Historically, it has been in the public interest for public utility facilities to use and occupy the rights-of-way of public roads and streets, especially on local roads and streets that provide a land service function to abutting residents, and on conventional highways that serve a combination of local, state, and regional traffic needs. This practice has generally been followed nationwide since the early formation of utility and highway transportation networks. Over many years, it has proven to offer the most feasible, economic, and reliable solution for transporting people, goods, and public service commodities (water, electricity, communications, gas, and oil), all of which are vital to the general welfare, safety, health, and well-being of our citizens. To have done otherwise would have required a tremendous increase in the acquisition of additional rights-of-way for utility purposes alone, resulting in significant added costs to be borne by the utility consumers through increased rates for utility services.

Certain general principles emerge from studying the statutes and related case law. State legislatures possess and exercise sovereign control over all highways within their jurisdiction, and are responsible to the general public for the construction, maintenance, and improvement of those highways. Some legislatures delegate their control over some of these highways to state highway departments, and their control over other highways to the various local governmental units traversed by those highways. The highways are, naturally, designed primarily for the use of the traveling public. They may, however, be used for any purpose which serves the public's interest in transportation, communication, or health. Thus, it is a generally accepted principle, often codified in statute, that public utilities designed to serve these public purposes may also use designated classes of the highways for the location of their facilities and equipment, provided that this use does not inconvenience or hamper the public in its ordinary use of the highways, and subject to various qualifications and regulations. Many of those states which have specific authorizations require the utilities first to obtain

²¹See *Multiple Use of Lands Within Highway Rights-of-Way*, Barton-Aschman Associates, National Cooperative Highway Research Program, Report No. 53, Highway Research Board, National Academy of Sciences, National Academy of Engineering (1968) and "Longitudinal Occupancy of Freeways by Utilities," Draft Final Report, Byrd, Tallamy, MacDonald and Lewis, National Cooperative Highway Research Program, Transportation Research Board, National Research Council, January 1978, p. 44.

the consent of the highway department or of the municipality through which the highway passes. And in all states, the construction, maintenance, and repair of the utility facilities are subject to the supervision and control of the highway department or local governmental unit, as provided either specifically by the terms of the statute or other permission, or implied under general common law principles. Even if the utility constructs its facilities within the public right-of-way of the highway with the express permission of the state, of the highway department, or of the local community, the utility's rights are secondary and subordinate to the interests of the traveling public. However, if an agency of state government, in entering into a contractual relationship with a utility, commits itself to a certain course of conduct in the future, Constitutional questions could arise, under the "impairment of contract" clause (Art. I, Sec. 10, Clause 1), should the state later attempt to "go back" on its commitment.

Statutory provisions permitting the use of public highways and streets by public utilities were found in each of the 21 states (see Table 11). While such use of the highways is universally permitted by statute, restrictions of various kinds are placed on the occupancy by utilities of public highway rights-of-way. A franchise, permit, or other permission to occupy the highway rights-of-way by all utilities, obtained from the state highway department or other appropriate body, may be required by statute. In other states, a franchise, permit, or other permission must be obtained by designated utilities (not all utilities) for occupancy of the state highways.

Statutory provisions relating to the occupancy of the public highway rights-of-way by utilities sometimes required that such utilities conform to regulations promulgated by the state highway department or other appropriate body. Some 17 states have laws containing such requirements for all utilities. Similar laws involving only specified (rather than all) utilities can be found in other jurisdictions. In some states, statutes required specified utilities occupying any public street or highway to conform to regulations promulgated by the appropriate public agencies. And finally, the laws of some states contain a statutory provision permitting specified public utilities to occupy state highway rights-of-way on the condition that their facilities do not interfere with ordinary use of the highway.

State Authority to Require Payment of Fees. By virtue of their sovereignty and their property interest in the rights-of-way, all states have the power to charge fees for use of the rights-of-way. State constitutions do not appear to prohibit charging fees, so the legislatures may pass laws setting fee structures. In addition, where the legislature is silent on the subject, it may be that the legal authority for the state

Table 11
STATE HIGHWAY LAW SURVEY

State	Statutes Permitting Utilities to Use Public Roads	Utility Relocation Statutes	Laws Governing Fees for Utility Access to State Highways
Alaska	Highways and Ferries §19.25.010	Highways and Ferries §19.25.020	Chapter 19, Sec. 25.200
California	Streets and Highways §§709-711	Streets and Highways §§702-707	Streets and Highways Code, Sec. 671.1
Colorado	§38-5-101	§43-1-225	
Connecticut (T)	Highways and Bridges §13a-126c	Highways and Bridges §13a-126c	Title 13A-126c
Florida (T)	Public Transportation §337-401	Public Transportation §337-403	
Georgia	§46-5-1; 95A-936	§§32-6-170-32-6-173	Code of Public Transp.
Illinois (T)	Roads and Bridges §9-113	Ill. Ann. Stat. Title 121-Sect. 3-107	Roads and Bridges 9-113
Kansas (T)	Roads and Bridges §68-413b	Roads and Bridges §68-415	
Maine (T)	Pub. Util. & Carriers 35§2341, Hwys 23§304	Highways 23§255	Title 23, Secs. 54,3554
Maryland (T)	Md. Ann. Code Transp. Sect. 8-324(A)(3) Article 23, Sec. 340	Md. Ann. Code Transp. Sect. 8-506	Transportation Code, 8-646
Missouri	§229.100	§227.240	Title 14, Sec. 229.340
Montana	Mt. Code Ann. 69-4-101	Highways & Transp. §60-4-101-§60-4-403	
Nebraska	Rev. Stat. Neb. 39-1361	Highways and Bridges §39-1304.02	State Highways, 1361
New Hampshire (T)	Transportation §§231.160-231.161	N.H. Rev. Stat. Ann. Sect. 230:12	Highways, Bridges and Turnpikes, 236:10
New York (T)	Transportation Corporations Law §27	McKinneys Con L N Y Ann. Hwys Sect 10-24-B	Transportation Law, Sec. 14.22
Ohio (T)	Roads-Highways-Bridges §5515.01	Roads-Highways-Bridges §1403	Roads, Highways, Bridges, Sec. 5515.01(F)
Oklahoma (T)	Roads, Bridges and Ferries §1401, §1402	Roads, Bridges and Ferries §1403	Roads, Bridges and Ferries, 1401(b)
Oregon	Utilities, Railroads, other Carriers §758.010 Hwy, Rds, Brid & Ferr. §374.305	Or. Rev. Stat. Ch. 366-321	Utilities, Railroads, other Carriers, Sec. 758.010(1)
Pennsylvania (T)	Highways & Bridges §670-411	Highways & Bridges 36-§670-412	State Highway Law, Sec. 670-411
Tennessee	Pub. Util. & Carriers §65-21-101 Hwys, Bridges & Ferries §54-19-110	Hwys, Bridges & Ferries §§54-5-801-54-5-807	Rules and Regulations, Ch. 1680-6-1
Wyoming	Wyo. Stat. Sect. 17-12-107 (Telegraphs only)		

NOTE: T = turnpike state.

highway administrator is broad enough to permit contracting for fees without additional legislation. However, additional in-depth state-by-state analysis will be required to determine whether this is the case.

Present authority to require compensation for highway access varies from state to state. Figure 8 shows the fee structures for the 21 states in our survey. Some states, including California, Colorado, Oklahoma, Georgia, Pennsylvania, New York, Connecticut, Maine, Illinois, and Alaska have statutes permitting fees to be charged. Two states, Oregon and Ohio, have statutes expressly prohibiting the charging of fees. Other state legislatures have been silent on the issue; they include Montana, Wyoming, Nebraska, Kansas, Tennessee, Florida, Maryland, and New Hampshire. Some states require utilities to restore highways or to post a bond, in lieu of fees. These states are designated by "R/B" in Fig. 8.

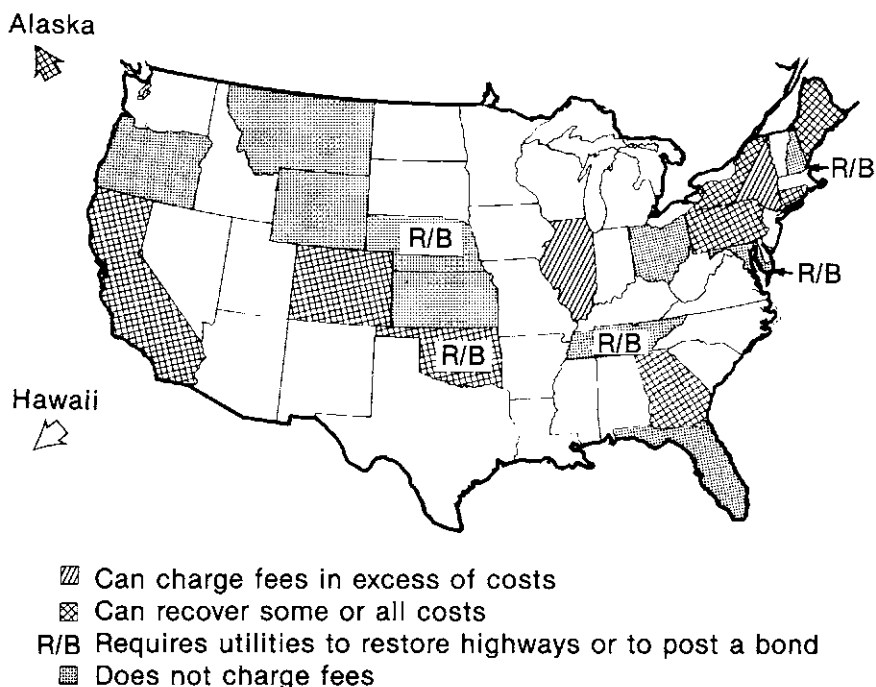


Fig. 8—State fee structures

In states that do have fee statutes, the basis for the fee varies extensively. Some states restrict fees to cost recovery, although the meaning of that varies with the state. It can mean simply recovering the administrative cost of granting the permit—perhaps \$100 or less—or it can include the cost of restoring the right-of-way to initial conditions. Sometimes the latter is ensured by requiring the posting of a bond. In Georgia, the fee includes indirect costs involving future maintenance of the right-of-way. The intent here is to recover from the utility the increases in highway construction bids that have been found to occur where utility lines have been placed. Based on an analysis of bid data, Georgia has charged \$5000 per mile per year for utility access to urban highways and \$1000 to \$2000 per mile per year—depending on traffic volume—for access to rural highways. Other states recover more than their cost. For example, in Illinois, in certain circumstances, the recovery is based on the fair market value of the land involved. New York has a dual system—fees can exceed costs for trunk lines but not for distribution lines.

Political Considerations. Legal authority to grant access to the rights-of-way does not, of course, automatically imply that the carriers will have access. The states must also have the political will to take advantage of their authority. To address this issue we looked at several surveys of state officials to get an idea of state attitudes toward Interstate right-of-way access for fiber optics.

Survey of State Highway Officials. Authorization of the RAND study together with increased pressure from industry caused concern within AASHTO that the long-standing FHWA policy to keep utilities off Interstate ROW was about to erode. Much time, effort, and money have been expended in the furtherance of this policy²² and for good cause—it has contributed significantly to the U.S. Interstate system being the safest highway system in the world. Consequently, in September 1985, the AASHTO Fiber Optics Task Force was organized and charged with:

1. Exploring the need for a change in the AASHTO *Policy on the Accommodation of Utilities Within Freeway Right-of-Way* and,
2. Developing recommendations for a potential change to the present AASHTO policy.

The Task Force started out with a questionnaire to all 50 AASHTO member departments to gauge sentiment. The results for three key questions are shown in Table 12. Note that the first question, as

²²It is estimated that the total cost of utility adjustments in conjunction with the Interstate program has been in the \$3–4 billion range.

Table 12

RESULTS OF SURVEY OF STATE HIGHWAY DEPARTMENTS

1. "Should the AASHTO policy on the accommodation of utilities within freeway right-of-way be modified to permit the longitudinal installation of utilities?"	
	7 Yes
	35 No
	8 No response
2. "Would your Department's position be different if use were limited to underground fiber optics systems?"	
	2 Yes
	39 No
	1 Undecided
3. "Would your Department support use of Interstate ROW for a National Defense communications system?"	
	22 Yes
	15 No
	5 Undecided

phrased, does not limit the policy change to fiber-optics installations. As far as utility access in general is concerned, over 80 percent of the respondents do not think there should be any change in the existing AASHTO policy. Even if right-of-way use could somehow be limited to underground fiber-optics systems, over 75 percent are still opposed to change. But when the concept of national security is introduced, resistance drops dramatically—about 52 percent support defense use of the Interstates, whereas 12 percent are undecided.²³

The AASHTO survey brought out the concerns of highway officials regarding utility access. Perhaps the major concern expressed by those in opposition was poor experience with utility contractors during installation and subsequent maintenance of utilities. Evidently, utility contractors have ignored safety requirements and violated the construction standards imposed upon them as a condition of receiving a permit to use the right-of-way. During maintenance, utility trucks sometimes use the right-of-way to get to the area involved, even though their permits authorize access only from outside the access control lines.

²³Based on a telephone conversation with Duane Christensen, Chairman of the AASHTO Fiber Optics Task Force, all respondents knew that the concept implicit in a "national defense telecommunications system" was a hardened commercial system and not a dedicated, government-owned system.

Proliferation was another concern here. Fiber optics appears innocuous compared with other utilities. It installs easily and does not have severe environmental impact or major maintenance requirements. It is inherently safer. However, state officials appear to believe that once one utility is given permission to use the Interstate right-of-way, it will be difficult to prohibit others from doing so.²⁴

Based on the results of the questionnaire, the Task Force made the following *preliminary* recommendations:²⁵

(1) That the present policy of accommodation of utilities within freeway right-of-way should not be changed unless mandated by the Federal government for national defense security.

(2) That in the event of a mandated change, a new section be added to the AASHTO utility accommodation policy entitled "National Defense Telecommunication Installations on Freeways" with the following subparagraphs:

- A. National defense communication cables will not provide for or be leased for any commercial use.
- B. The installation will be limited to a corridor at the extremities of the right-of-way wherever possible.
- C. The installation in the median area will be allowed only as a last resort and with the approval of the respective State Department of Transportation.
- D. All installations will be buried underground, either by direct burial or conduit installation as required by the respective State.
- E. States will not be liable for repair and/or cost to relocate under any conditions.
- F. Conflict with all other existing utilities will be resolved by and be the total responsibility of the National Communications System.
- G. Sections 2(A), (B), and (C) of the existing policy shall apply.²⁶

²⁴However, as suggested by the discussion of proliferation at the end of Sec. III, we do not share this opinion.

²⁵"Status Report of the AASHTO Fiber Optics Task Force," presented to the Standing Committee on Highways by Duane Christensen, Chairman, AASHTO Fiber Optics Task Force, June 1986.

²⁶Section 2 of the existing policy sets strictly controlled conditions for new utility installations within the access control lines. The utility owner is required to show that:

- A. The accommodation will not adversely affect the safety, design, construction, operation, maintenance or stability of the freeway;
- B. The accommodation will not be constructed and/or serviced by direct access from the through traffic roadways or connecting ramps;
- C. The accommodation will not interfere with or impair the present use or future expansion of the freeway.

Although each of these items has implications for potential fiber installations, it is the prohibition on commercial use (A) that stands out. It is completely contrary to the exchange concept envisioned by NCS. However, to reiterate, the recommendations listed above are preliminary and do not in themselves constitute a change in AASHTO policy. Two of the AASHTO regional organizations—the Northeastern and Southeastern Association of State Highway Officials (NASHTO and SASHTO, respectively) have passed resolutions on control of utility access on Interstate rights-of-way, independently of the Fiber Optics Task Force. In fact, the SASHTO resolution²⁷ preceded organization of the Task Force. SASHTO strongly supported the existing AASHTO policy, and specifically opposed *any* relaxation of current FHWA or state access control policies. Seven months later, NASHTO assumed an intermediate position, supporting use of Interstate rights-of-way for installation of fiber-optics cables where they would not interfere with the primary purpose of the highways.²⁸ NASHTO also reaffirmed its support for the “basic principles” of existing federal policy.

Survey of State Governors. The results of the AASHTO questionnaire and the NASHTO resolution suggest that state highway officials are relaxing their opposition to right-of-way access somewhat, at least if a way can be found to distinguish fiber optics from other utilities. Since doubt persists as to whether a rational basis can be devised that will survive challenge in the courts, response to the idea is, at best, equivocal.

A similar reaction can be inferred from the responses to a letter sent out by the governor of New York. The Governor has come to believe that the installation of fiber optics on Interstate rights-of-way would prompt economic growth and development in his state and others. In January 1986, he addressed a letter to the governors of the other 49 states outlining all the benefits he believed would accrue to the states if fiber-optics installation were permitted. He requested support in this manner: “If you determine that the use of fiber optics cables would prove beneficial to your state, I encourage you to work with me in efforts to revise the outdated federal restrictions that now block access to the Interstate rights-of-way.” The “outdated restrictions” referred to are the FHWA regulations based on current AASHTO policy. The letter did not mention national security aspects.

²⁷See App. C, Item 3.

²⁸See App. C, Item 8.

The responses are shown in Fig. 9. Ten states gave outright support while four expressed outright opposition. Note that six of the ten states providing support are in the Northeast, an outcome that undoubtedly reflects the fact that the governor of New York was at the time also the Chairman of the Coalition of Northeastern Governors (CONEG). Of the 17 equivocal responses, 11 states expressed qualified support (i.e., the states were interested in the basic concept but voiced concerns about safety and proliferation) whereas the remaining six were noncommittal (e.g., cited need for additional review). Consequently, of those responding, support ranged from 33 to 67 percent depending on how one views "qualified support." Thus, as one would expect, the state governors are more favorably disposed to modifying the federal policy than are the state highway departments.

The independence of the state highway authority may have a bearing on these responses. Most states have a semiautonomous highway board or commission (see Fig. 10). In 30 states, the commissioners serve for fixed terms. Once appointed by the governor, they cannot be

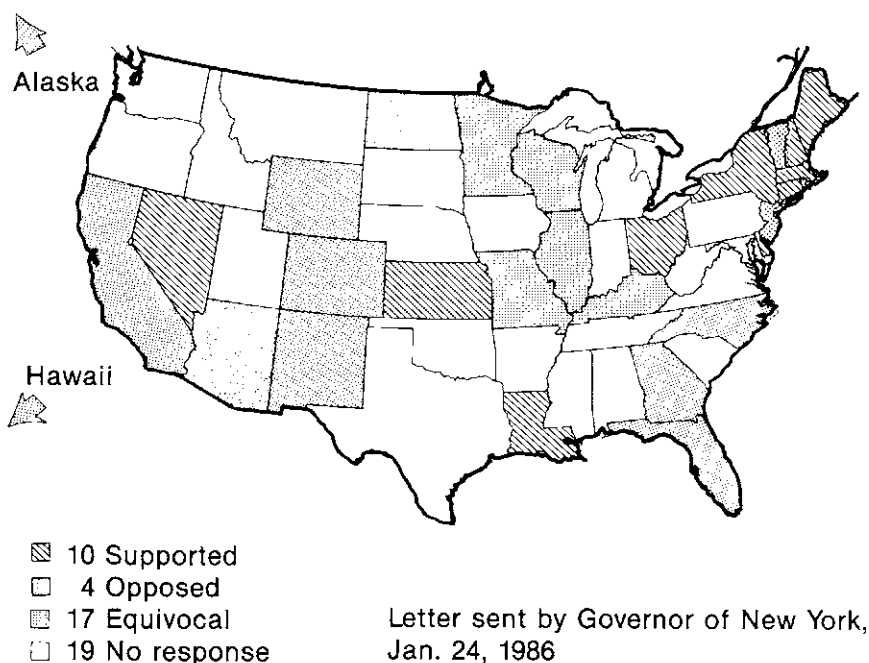
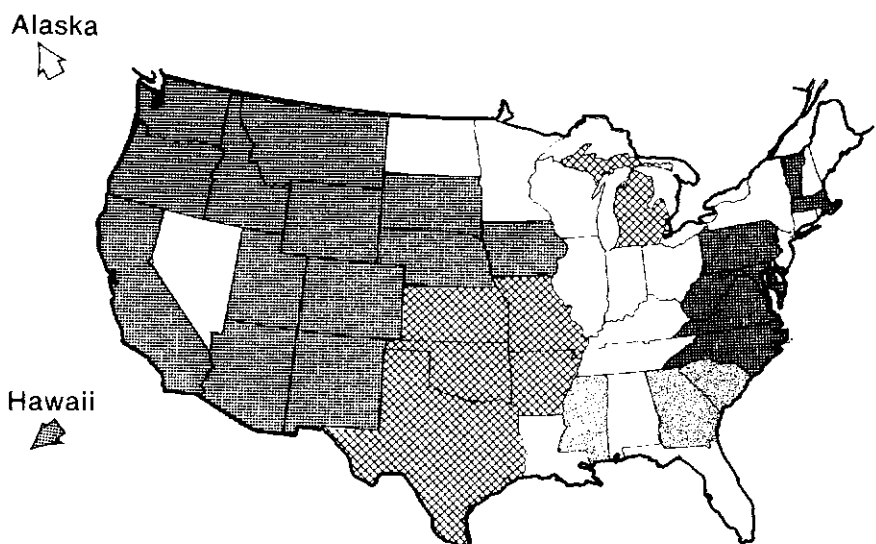


Fig. 9—Results of survey of state governors



Legend:

- Elected Board/Commission - 3
- Appointed Board/Commission - 21
- ▨ Appointed Board/Commission (expressly staggered by law) - 6
- Highway Dept. - 20

Fig. 10—Influence of governors over state highway departments

removed except for criminal activity. In six of these states, the commissioners' terms are staggered so an incoming governor cannot appoint a whole new commission, which gives them even more autonomy. In three states, the commissioners are elected, which increases their autonomy. In 20 states, the highway commissioner or secretary of transportation serves at the pleasure of the governor and can thus be dismissed at will.

From an aggregate point of view, there are two possible perspectives. One view is that in 41 of the 50 states, the highway commissioners and board members owe their allegiance to the governor who appointed them. On the other hand, one might argue that in 30 of the 50 states, board members enjoy a degree of autonomy because they serve for fixed terms and can only be removed for cause. Unfortunately, more

definitive statements cannot be made with the information at hand. The degree of independence each state highway department actually enjoys is very much determined by their enabling statutes, as well as historical precedent within the state.

INDUCED STATE COOPERATION

One possible means of *inducing* ROW continuity would be for Congress to pass legislation tying federal highway aid to a state's opening of its Interstate ROW. Precedent exists in the 55-mph speed limit, emission controls under the Clean Air Act, and the national minimum drinking age. Since a state is free to reject the aid and keep its ROW "closed," this option does not guarantee a continuous backbone. However, past experience has shown that no state has ever refused to go along with the federal "recommendations" (at least for more than a year or so).

Legal Precedent

In 1956 the Federal-Aid Highway Act of 1956 created a trust fund for financing the expanded federal highway program. Depending on the project, federal funding generally varies from 50 to 95 percent of the total amount.²⁹ To receive these federal funds, states must comply with certain requirements or conditions that promote federal policies and programs: for example, the control of signs along certain highways; the control of junkyards along certain highways; payment of the prevailing wage on all federal-aid projects under the Davis-Bacon Act; weight and size limits on Interstate highways; provisions for local planning in urban areas; provisions for protection of the environment; protection of park land; protection of air quality; and inspection and approval of construction by the Federal Highway Administration on all federal-aid projects—to name but a few of the federal-aid conditions.

The imposition of such conditions has survived legal challenges. In a recent Illinois case, a motorist challenged the constitutionality of the national maximum speed limit. This law³⁰ was passed in 1974 to conserve fuel. It conditioned approval of federal highway construction funds upon state reduction of the maximum speed limit to 55 miles per hour. Despite characterization of such action as "bribery," the 55 mph speed limit was upheld as constitutional.³¹

In *EPA v. Brown*, 431 U.S. 99 (1977), counsel for the states contended that Congress could not require state legislation designed to

²⁹23 U.S.C. 120.

³⁰23 U.S.C. 154.

³¹*People v. Austin*, 111 Ill. App. 3d. 213, 443 N.E. 2d 1107 (1982).

effectuate Congressional programs. However, the counsel also recognized that Congress could accomplish the same purpose by conditioning federal aid on such legislation. And, indeed, this was later done. 42 U.S.C. 7506, enacted in 1977, directs the Secretary of Transportation not to approve any projects or grants under Title 23 in any air quality control region where the national ambient air quality standard has not been attained and other specified conditions have not been met.

Most recently, Congress authorized the Secretary of Transportation to withhold apportionment funds from states where purchase and possession of alcoholic beverages by persons under 21 years of age is lawful.³² Its constitutionality was recently upheld by the Supreme Court.³³

Although many of these conditions appear designed to promote highway interests, some, such as payment of the Davis-Bacon Act wage, have clearly been promulgated for other ends. Thus, there appears to be no hard and fast requirement that the condition imposed be related in more than a very indirect way to highway interests. In any case, a fiber-optics system intended to promote more efficient communications would undoubtedly support the Interstates' defense function. This would be particularly true if NSEP enhancements were incorporated in the system.

Political Considerations

The success of any attempt to ensure ROW continuity for the proposed exchange concept by linking federal highway funds to a state's granting of access will ultimately depend on the level of political support that can be generated. As indicated below, a fair number of individuals and groups could be expected to take an active interest in any such proposed legislation:

- The President
- National Security Community
- National Security Council
- Department of Defense
- Federal Emergency Management Agency
- Transportation Community
- Secretary of Transportation
- Federal Highway Administration

³²23 U.S.C. 158, enacted 1984.

³³*South Dakota v. Dole*, 107 S.Ct. 2793 (1987).

State highway departments and American Association of
 State Highway and Transportation Officials
 American Automobile Association
 Trucking industry
 State governors
 Congressional staff
 Utilities
 Communications companies
 Water, power, and oil and gas distribution companies
 Owners of Alternative ROWs (e.g., railroads)

We cannot say what the likelihood of passing this type of legislation is.³⁴ Whereas the position of some groups would appear to be fairly straightforward (e.g., state highway departments), others are less so (e.g., noncommunication utilities). Furthermore, even if a group has a clear-cut position, it is difficult to gauge the relative importance that the group might attach to this issue. However, of one thing we are reasonably certain—without the wholehearted support of the national security community and the President, the proposed legislation stands little chance of succeeding.

COMPELLED STATE COOPERATION

In addition to voluntary approaches, the *possibility* exists that the federal government might be able to compel states to grant access to Interstate ROW. However, neither the Constitution nor any federal statute authorizes the U.S. government to compel the states to open the rights-of-way, at least in the absence of a state of war or national emergency. This lack of authority is due in part to the fact that the federal government has no property interest in the rights-of-way: the states either own the rights-of-way in fee simple or have acquired easements or other nonfee property interests.³⁵ Thus, the ownership of

³⁴Given the rudimentary and highly conceptual nature of both the proposed legislation and the access-for-hardening concept, we did not feel that any confidence whatsoever could be placed in a detailed political assessment undertaken at this time.

³⁵Historically, Interstate rights-of-way have been acquired by the states with federal funds, by states with state funds and later incorporated into the Interstate system, or by the federal government acting on request of the state. Congress has directed the Secretary of Transportation to convey such lands to the appropriate agency in the state (23 U.S.C. 107(c)). In either case, title to the lands is held by the state, not the federal government. See *Mahler v. United States*, when the court, in discussing the respective

these lands belongs to the states and the Constitution prohibits the "taking" of property. However, it is important to recognize that "takings" are unconstitutional only if they are unaccompanied by "just compensation." Under the proposed plan, the carriers would be obligated to pay any state-imposed right-of-access fees. Consequently, assuming that such fees approximate "fair market value," the fee itself would provide the "just compensation" that would render a "taking" constitutional.³⁶

In the following paragraphs, we examine three *possible* approaches to implementing the "taking-with-just-compensation" option: (a) congressional power of eminent domain; (b) federal administrative action; and (c) Presidential war and emergency powers.

Congressional Power of Eminent Domain

Congress has the power to take private property for public use without the owner's consent, upon payment of just compensation.³⁷ The proposed plan for enhancing postnuclear attack communications would clearly seem to satisfy the "public use" requirement. And carrier payment of fees for the right-of-access would, as mentioned above, seem to satisfy the "just compensation" requirement. Thus, we believe Congress could legally use its power of eminent domain to ensure ROW continuity. Ultimately, however, the success of this approach will depend not so much on its legality but rather on its political support. Whether it would enjoy more or less support than the "tie to federal highway aid" is anybody's guess. Some in Congress may view it as a guaranteed way to ensure ROW continuity whereas others may view it as upsetting the well-established legal and policy balance of state and federal authority over the Interstate system.

roles of the states and the federal government in relation to a highway built in part with federal funds, stated: "the States are at all times the owners of the roads . . ." 306 F.2d 713 (3d Cir. 1962). Nowhere does highway legislation reserve to the Secretary or his delegate the right to compel the states to open the rights-of-way.

³⁶Unfortunately, the proposed exchange concept cannot guarantee either immediate or long-run carrier interest in Interstate ROW. Thus, some doubt is raised as to when (and even if) states would receive compensation for Interstate ROW "taken" from them. Since it is not clear how courts might view such circumstances (or whether the situation could be finessed in some legal manner), the legality of the proposed compensation mechanism is subject to a degree of uncertainty.

³⁷The taking of private property for public use is an inherent attribute of sovereignty and requires no explicit constitutional recognition. The right to "just compensation" is guaranteed by the Fifth Amendment to the U.S. Constitution.

Federal Administrative Action

Administrative Authority Delegated to FHWA. Pursuant to 23 CFR 645.209(c), the FHWA *may approve* the placement of utility installations on federal-aid highways if it is determined that such use is in the public interest and will not impair the highway or interfere with the free and safe flow of traffic. However, the conditions of access put forth in this rule are fairly restrictive:

Since the preservation of the control of access feature of freeways is essential to the safe and efficient use of such highways, longitudinal utility use of freeway right-of-way within the access control lines will not be permitted unless such use is clearly justified due to special and unique circumstances and when denial of such use would result in undue or exceptional hardship on utility consumers or others.

Moreover, while 23 CFR 645.209(c) sets the standard for approving utility installations on Interstate rights-of-way, it also states:

(N)othing in this part shall be construed as prohibiting a highway agency from adopting a more restrictive policy than that contained herein with regard to longitudinal utility installations along freeway right-of-way and access for constructing and/or servicing such installations.

On the other hand, 23 U.S.C. 109 and 23 U.S.C. 315 provide the FHWA the necessary legal authority to modify the restrictive nature of 23 CFR 645.209(c). However, it is important to note that 109(b) of Title 23 states that "the geometric and construction standards to be adopted for the Interstate System shall be those approved by the Secretary in cooperation with the State highway departments." While formal definitions of "in cooperation with" do not exist, it would seem that the Secretary must, at a minimum, *consult* with the state highway departments.³⁸ Consequently, depending on the circumstances, any attempts by the Secretary to act unilaterally in this area might be subject to judicial challenge.

In summary, even though the federal highway statutes and regulations provide the U.S. government with some authority over the rights-of-way, these powers do not vitiate state authority in this area; rather, they confirm it, at least as far as utility facilities are concerned.

³⁸In the past, the FHWA has satisfied the "in cooperation" requirement by incorporating AASHTO-approved policies and standards into its regulations by reference. Furthermore, over the past 25 years, the FHWA has only once stipulated an exception to AASHTO's utility accommodation policy and that was of a relatively minor nature. Note, however, that the revising of 23 CFR 645.209 now taking place appears to be an exception to the historical process since the federal government seems to be intent on liberalizing the conditions of access while AASHTO favors retention of the status quo.

Emergency Preparedness Authority Delegated to FEMA and NCS. The Civil Defense Act of 1951, as amended, is the statute seemingly most likely to grant the Executive branch power to compel states to open the rights-of-way.³⁹ The Act authorizes the Director of the Federal Emergency Management Agency (FEMA) to "make appropriate provision for necessary civil defense communications and for dissemination of warnings to the civilian population of an attack or natural disaster."⁴⁰ It also requires the President "to the extent practicable," to "develop and implement an improved civil defense program which includes

- The improvement of civil defense warning systems; and
- The improvement of systems and capabilities for direction and control of emergency operations by civil governments at all levels, including further development of a network of emergency operating centers."⁴¹

This statute, of course, contains no grant of authority purporting to enable the President or the FEMA administrator to override either the U.S. Constitution or its state counterparts.⁴² Thus, this section cannot provide authority to compel states to open the rights-of-way to a fiber-optics system.

Similarly, Executive Order No. 12472 directs the National Communications System (NCS) to "ensure that a national telecommunications infrastructure is developed which . . . is responsive to the national security and emergency preparedness needs . . . including telecommunications in support of national security leadership and continuity of government."⁴³ However, this cannot and does not authorize the NCS to disregard the states' constitutional rights. And indeed, plans formulated pursuant to this order must be "consistent with law."⁴⁴

³⁹50 U.S.C. App. 2251 *et seq.*

⁴⁰50 U.S.C. App. 2281(c).

⁴¹50 U.S.C. App. 2302 (b)(9) and (b)(10).

⁴²See discussion of emergency powers in next subsection.

⁴³Executive Order 12472, Sec. 1(c)(1), signed by President Reagan on April 3, 1984, published in *The Federal Register*, April 15, 1984. The NCS was established by President Kennedy in Memorandum of August 21, 1963, "Establishment of the National Communications System," 23 FR 9413.

⁴⁴Executive Order 12472, 1984, Sec. 3(i).

War and Emergency Powers of the President

During times of national crisis, the President might be able to exercise extraordinary powers to compel opening of the rights-of-way. The President as Commander-in-Chief of the armed forces can do many things in wartime that he cannot do in peacetime. Additionally, the President has special powers that can be exercised only in times of national emergency, pursuant to specific statutes.

Although Congress has the constitutional power to declare war and to make appropriations for the support of the military forces,⁴⁵ the President is vested with the executive power of the government and named the Commander-in-Chief of the military forces.⁴⁶ Despite recent and controversial expression of congressional desire to be involved in military decisionmaking,⁴⁷ the President has the authority to introduce the armed forces into "hostilities" or "imminent hostilities." These powers are considerable and could well serve as the basis for compelling states to open rights-of-way to fiber-optics systems serving national defense needs. During the Korean War, however, the Supreme Court denied President Truman the authority to seize private property. When a nationwide steel strike appeared imminent in April 1952, Truman directed the Secretary of Commerce to seize and operate the steel mills in order to assure production of essential war materials. Truman argued that the strike would imperil national defense, resting his position on the inherent powers of the office of the President during an emergency, even in the absence of specific statutory authority. The Supreme Court nullified this action, holding that such action as seizure of steel mills by the executive must always be based on express legislative authorization.⁴⁸

By analogy, overriding state property rights in the rights-of-way to permit installation of NSEP fiber-optics communications lines in time of hostilities or imminent hostilities could be accomplished by the President pursuant to specific legislative authorization. However, it seems unlikely that Congress would endorse such an action in any crisis short of direct attack upon the United States, when it would be too late to install a fiber system at the rate of 6 to 10 miles per day.

We also reviewed the President's emergency powers—specific delegations of Congress' constitutional (Art. I, Sec. 8) powers to the

⁴⁵U.S. Constitution, Art. I, Sec. 8.

⁴⁶U.S. Constitution, Art. II, Sec. 1 and Sec. 2.

⁴⁷War Powers Resolution, 50 U.S.C. 1541 et seq. was enacted on November 7, 1973 over President Nixon's veto.

⁴⁸*Youngstown Sheet & Tube Co. v. Sawyer*, 343 U.S. 579 (1952).

President. The National Emergencies Act⁴⁹ provides for the declaration of national emergencies by the President and the subsequent approval or termination of the emergency by Congress.⁵⁰ Only subsequent to the Presidential declaration may he exercise special or extraordinary powers set forth by statutes authorizing their exercise. Some of these powers are quite broad. Under the Federal Communication Act of 1934, the President may modify broadcasting licenses, close communications facilities and remove equipment, cease publication of regulations, and authorize government use or control of communications facilities.⁵¹ Highway legislation contains no such emergency or wartime provisions.

None of the statutes pertaining to communications and transportation appear applicable to opening the rights-of-way. But in time of genuine crisis, the language of these acts might be stretched to cover the situation, even if later perhaps rejected by the courts. As a practical matter, installation of a nationwide backbone system would take a long time, longer than available in an emergency.

SUMMARY

A summary of the legal and political feasibility of the five possible options for obtaining backbone ROW continuity is presented in Table 13. As indicated, we could find no legal basis for either the President or agencies within the Executive branch compelling states to grant access to their Interstate ROW and can therefore dismiss these options. Of the remaining options, voluntary federal/state cooperation is undoubtedly the most attractive from a political perspective. However, because of the strong opposition of the state highway departments, we do not feel that this option is likely to produce backbone ROW continuity. On the other hand, from a practical standpoint, the two remaining options (tie to federal highway aid and condemnation of required easement) are both quite likely to produce the necessary continuity. However, both of these options require congressional approval and at this time we are unable to say what type of political support they might enjoy.

⁴⁹50 U.S.C. 1601 et seq.

⁵⁰Only a President can declare a state of national emergency. The War Powers Act reaffirmed that Congress has the sole authority to declare war.

⁵¹47 U.S.C. 606.

Table 13

SUMMARY OF OPTIONS FOR OBTAINING BACKBONE ROW CONTINUITY

Option	Legally Feasible?	Politically Feasible?
Voluntary federal/state cooperation		
Federal change	Yes	Yes ^a
State cooperation	Yes	Very doubtful
Induced state cooperation (tie to federal highway aid)	Very likely	Unknown
Compelled state cooperation		
Congressional power of eminent domain	Very likely	Unknown
Through authority delegated to Executive branch	No	Not relevant
Presidential war and emergency powers	No ^b	Not relevant

^aModification to existing rule now in final stages of review/approval.

^bSince the intent of the proposed plan is to have a hardened backbone that is in-place at the time of imminent hostilities and not one on which construction is just being started, use of the President's war/emergency powers is basically a moot point (that is, construction would have to be initiated at a time when a legal basis does not exist).

V. AUTHORITY TO REQUIRE NSEP ENHANCEMENTS

In addition to ROW backbone continuity, the feasibility of the proposed exchange concept depends on obtaining a minimum level of hardness on all system segments. In this section, we examine possible approaches to securing this minimum level of hardening.

VOLUNTARY STATE ADOPTION OF STANDARDS

One of the powers incident to state sovereignty is the power to provide for the public welfare. This includes the right to contract for the use of state-owned property, such as highway rights-of-way, for the public interest, such as utility usage. Therefore, because the states own the Interstate rights-of-way, they have the power to contract with private carriers who desire to use the rights-of-way. Moreover, all states have the authority to impose construction standards for projects using state-owned property. Therefore, we have concluded that all states have the power to contract for NSEP enhancements.

The real difficulty is not, however, with respect to the states' authority to impose standards, but rather with persuading *all* states comprising the backbone network to impose a minimum level of hardening as a *quid pro quo* for utility access. Even if all the states along the backbone route grant access (which is highly unlikely¹), those that do so grudgingly may promote relatively high minimum standards in order to discourage carrier interest. But there will be other states that will want to maximize revenues and/or encourage fiber installation and will therefore try to keep NSEP standards as low as possible. Consequently, reaching agreement among the states would appear to be a formidable task.

FEDERAL IMPOSITION OF STANDARDS

Through Authority Delegated to FHWA

Because the states, not the federal government, own the rights-of-way, the federal government has no power to contract with private car-

¹See discussion in Sec. IV.

riers who desire to use the rights-of-way. Thus, the federal government cannot by contract impose NSEP requirements, nor, with one possible exception, does it presently have any legal authority to impose NSEP enhancements on fiber-optics systems installed along the rights-of-way. The potential exception relates to the FHWA's authority to mandate geometric and construction standards on Interstate highways. Congress has granted the Secretary of Transportation authority to ensure that federal aid highways are safe, maintainable, and environmentally nondestructive. The Secretary may therefore approve only those projects "that will adequately meet the existing and probable future traffic needs and conditions in a manner conducive to safety, durability and economy of maintenance." To achieve this end, "geometric and construction standards to be adopted for the Interstate system . . . shall be adequate to enable such project to accommodate the types and volumes of traffic anticipated for such project"²

Although this statute mandates standards for highways, not communications systems, safety is an area where the two may overlap. Where survivability enhancements coincide with safety standards, the FHWA can probably impose standards.³ For example, underground installation of cable and regenerator stations results in less disruption to traffic flow and a safer right-of-way than above-ground installation. But the authority to impose safety standards may not be sufficient to encompass all the hardening required. For example, bridge and water crossings must be hardened in special ways that have no bearing on highway considerations. Even more importantly, NSEP enhancements may require that cable buried underground be hardened to a point far beyond that necessary for safety. Therefore, we conclude that the FHWA's authority to mandate geometric and construction standards probably will not permit the federal government to impose NSEP standards on fiber-optics systems using Interstate rights-of-way.

In Conjunction with Tie to Federal Highway Aid

As noted previously, Congress could condition federal highway aid to the states upon their opening of Interstate rights-of-way to fiber-optics installations. At the same time, Congress could also stipulate a specified level of hardness for such installations. In such circumstances, the states would have a strong incentive not only to grant access to fiber installations but also to require NSEP enhancements.

²23 U.S.C. 109(a).

³Note, however, that pursuant to 23 U.S.C. 109(b), any revisions to existing standards require that the Secretary consult with the State highway departments.

In Conjunction with Condemnation of Easement

As discussed in Sec. IV, Congress could exercise its power of eminent domain to guarantee ROW continuity. In such a case, it is the enhancements themselves that provide the distinguishing public benefit necessary for exercising this power. Consequently, implicit in the very exercise of the power is a specified level of hardening.

SUMMARY

A summary of the legal and political feasibility of the four possible options for obtaining NSEP enhancements is presented in Table 14. As indicated, we could find no legal basis for Executive branch action. Additionally, we are skeptical about the prospects of all backbone states agreeing on a uniform standard of enhancement. On the other hand, the two remaining options (tie to federal highway aid and condemnation of easement) are both likely to ensure that fiber systems installed on Interstate ROWs are hardened to a specified level. Both of these latter options require congressional approval and, at this time, we are unable to say what type of political support they might enjoy.

Table 14

SUMMARY OF OPTIONS FOR OBTAINING NSEP ENHANCEMENTS

Option	Legally Feasible?	Politically Feasible?
Voluntary state adoption of standards	Yes	Very doubtful
Federal imposition of standards		
Through authority delegated to Executive branch	No	Not relevant
In conjunction with tie to federal highway aid	Yes	Unknown
In conjunction with congressional power of eminent domain	Yes	Unknown

VI. ESTIMATED COSTS OF INSTALLING FIBER-OPTICS SYSTEMS ON INTERSTATE AND ALTERNATIVE TYPES OF RIGHT-OF-WAY

This section addresses what funds might be available for Interstate ROW payment after system NSEP enhancements have been made. We will:

1. Determine the total unenhanced costs for a number of non-Interstate ROW types;
2. Determine the costs of an enhanced Interstate ROW system net of right-of-way payments; and,
3. Subtract the cost of the enhanced Interstate system from the least-cost unenhanced alternative.

Supporting detail for the cost estimates in this section may be found in App. G.

SOURCES OF COST DATA

The cost estimates in this section are based on the experience of companies that have installed fiber-optics cables. The following eight carriers were contacted as potential contributors: AT&T Communications, MCI, U.S. Sprint, CONTEL, LiTel, BellSouth, Pacific Northwest Bell, and New York Telephone. Six of the eight provided data.¹ In addition, engineering firms and cable manufacturers were contacted as necessary.

COST CATEGORIES

Our survey requested data for five basic cost categories associated with initial installation: ROW acquisition, engineering, cable procurement, cable installation (placement, splicing, etc.), and regenerator procurement and installation (both structure and electronics). Our estimates do not include operations and maintenance costs nor do they include provisions for such potential occurrences as relocation and emergency cable repair.

¹Proprietary considerations prevent us from identifying the companies that provided data.

TYPES OF ROW CONSIDERED

Right-of-way types considered in addition to Interstate freeways were railroads, private land, and non-Interstate highways.² Furthermore, for the Interstates, we considered two (median and fence line) of three possible locations within the ROW (see Fig. 11). The median is the least-cost Interstate location (on deepest part of fill; fairly even grade and alignment; and probably little in the way of vegetation) but has the greatest potential effect on safety since installation vehicles

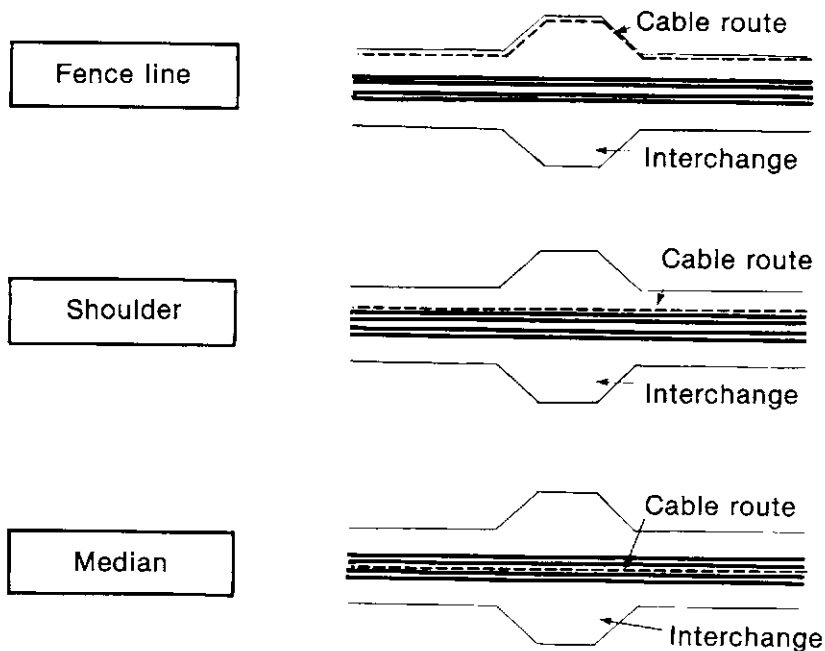


Fig. 11—Location concepts within Interstate ROW

²A non-Interstate highway is similar to an Interstate freeway in that both are intended for through traffic (i.e., long distance travel). However, they are differentiated from Interstates in that they are usually undivided, may have only two lanes, are not normally built on rock-free fill, and are not usually protected by fence. Furthermore, intersections are typically at grade and abutting property has direct access. In a rural environment, a non-Interstate highway may have two to four such "obstructions" (crossroads and business/residence driveways) per mile, whereas a rural Interstate will have only about 0.125 "obstructions" per mile (interchanges on average every eight miles).

would have to cross traffic lanes to gain access, and once there, could be in close proximity to high-speed traffic (depending on the width of the median). The fence line is the highest-cost Interstate location (fill, if it exists at all, is likely to be thin; grade and alignment will not be as even as in the median or along the shoulder; and presence of vegetation is quite possible). However, installation there would have minimal, if any, effect on safety. The shoulder falls somewhere in between the median and fence line from a cost perspective and probably does the same with respect to safety. Consequently, by selecting the median and fence line, we feel we have bounded the situation from both a cost and safety standpoint.

COST FIGURE OF MERIT

Our figure of merit for making cost comparisons among the alternative ROW types was “average installed cost per mile” in a rural, long-haul environment. The primary limitation of the “average installed cost per mile” approach with respect to inter-ROW cost comparisons is that it misses any savings achieved in route miles. Thus, the costs of the most direct ROW routes between cities will be somewhat overstated relative to less direct ROW routes. Additionally, the “average installed cost per mile” does not reflect the costs associated with major “random” obstructions—e.g., extensive rock formations and crossings of major rivers.

BASELINE SYSTEM

To assess the incremental costs associated with various levels of system hardening, it was first necessary to develop a baseline for today’s commercial systems. The fiber-optics system that we assumed to be typical of today’s commercial long-haul routes is characterized as follows:

Fiber characteristics	
Type	Single mode
Transmission loss	.4 db/km
Wavelength	1310 nanometers
Phosphorous content	Low
Cable characteristics	
Number of fibers/cable	24 (stranded)
Type of central strength member	Metallic ^a
Type of sheathing	Metallic
Burial depth	36 inches
Regenerators	
Structure type	Surface
Distance between	25 miles
Transmission rate	417 Mbps
Delivery of power	Local
Back-up power	Battery (8-12 hours)

^aAlmost all early fiber-optics cables had metallic central strength members. However, to reduce the potential for damage by lightning strikes, some firms have switched to cable with a nonmetallic central strength member (see David F. Peach, 1986, p. 6). The remaining firms continue to use cable with a metallic central strength member because of its lower initial cost. Thus, the choice of cable with a metallic central strength member as representative of current commercial practice is admittedly arbitrary.

COSTS FOR CURRENTLY USED ROW TYPES

The first step in assessing the magnitude of the Interstate cost advantage was to develop estimates of installed cable costs on non-Interstate ROW. The results, which reflect current commercial practice in a rural environment, are shown in Table 15. As indicated, total installed costs for the three non-Interstate ROW types are essentially equal, all being clustered within a few thousand dollars of the \$60,000 per mile mark. However, even though the totals are roughly equal and three of the five cost components are exactly equal, there are substantial differences in the cable installation and ROW acquisition components. Basically, where a ROW type has a particular installation cost advantage (e.g., the railroad), we see that the ROW owner extracts a good portion of that advantage.

Table 15
 INSTALLED COST ON CURRENTLY USED ROW TYPE^a
 (\$000 per mile)

Cost Category	Type of ROW		
	Non-Interstate Highway	Private Land	Railroad
Engineering	3.0	3.0	3.0
ROW acquisition	0.0	1.0	12.0
Cable procurement	16.6	16.6	16.6
Cable installation	27.0	22.0	10.0
Regenerators	15.2	15.2	15.2
Total	61.8	57.8	56.8

^aSupporting data are provided in App. G.

COSTS ASSOCIATED WITH INSTALLING ON INTERSTATE ROW

Current Commercial Practice

As indicated in Table 16, the cost (excluding ROW payment) of installing a fiber-optics cable in a rural Interstate median employing standard commercial practices is estimated to be \$45,000 per mile. Like the estimates developed for the non-Interstate ROW cases, this one is also based on carrier-provided information. Excluding the ROW payment category, the Interstate median components are identical to those incurred on railroad ROW. Similarly, the cost of installing a fiber-optics cable along the fence line would be about \$6000 per mile more, or about \$51,000 per mile.

Enhanced Systems

In Sec. I, it was stated that the vulnerabilities associated with current commercial systems could largely be alleviated by (a) burying *all* system components to a depth of 36 inches to provide protection against blast damage and fallout radiation and (b) providing a back-up power source that automatically kicks-in when needed and operates for some minimum period of time. Consequently, our baseline enhancement assumed that the following "standards" would apply to fiber-optics systems using Interstate ROW:

Table 16

INSTALLED COSTS USING INTERSTATE ROW^a
(\$000 per mile excluding ROW payment)

Cost Category	Location in ROW	
	Median	Fence Line
Engineering	3.0	3.0
Cable procurement	16.6	16.6
Cable installation	10.0	16.0
Regenerators	15.2	15.2
Total	44.8	50.8

^aThe value for the median installation assumes that the cable will be attached to the bridge structure whenever the Interstate passes over a crossroad or interchange. At the fence line the cable is assumed to be buried to the right of all Interstate structure, including on/off ramps (see Fig. G.2 in App. G).

- Burial of cable to depth of 36 inches under all obstructions such as crossroads, railroads, culverts, and rivers where attachment to the bridge structure would otherwise have been employed;
- Burial of regenerators to depth of 36 inches to protect electronics and looped cable; and
- Provision of back-up diesel generator with automatic kick-in and sufficient fuel for 14 days of operation.³

However, since these "standards" are fairly tentative, we also examined several alternatives (see Table 17). Alternative 1 assumes hardened surface enclosures for the regenerator stations rather than underground vaults. Alternative 2 assumes a nonmetallic central strength member for the cable, whereas Alternatives 3 and 4 assume increasingly stringent requirements for dealing with EMP and gamma radiation.

The costs associated with these alternative configurations are provided in Table 18. As indicated, the incremental cost associated with the baseline hardening is between \$5000 (fence line) and \$7000 (median) per mile. Using hardened surface enclosures rather than underground vaults (Alternative 1) will "save" about \$3000 per mile. On the other hand, eliminating the metallic central strength member

³Fourteen days is considered the minimum period of time before people could be out and around after a nuclear war.

Table 17
ENHANCEMENT LEVELS^a

		Enhanced System	
System Component	Current Commercial Practice	Baseline Enhancement	Alternative 1
Cable			
Fiber type	Single mode/low phosphor	Single mode/low phosphor	Single mode/low phosphor
Type of strength member/sheathing	Metallic strength member/metallic sheath	Metallic strength member/metallic sheath	Metallic strength member/metallic sheath
Installation provision	Median: Buried to 36 in. depth everywhere except grade separations, interchanges, and crossings of natural waterways (bridge attachment used) Fence Line: Buried to 36 in. depth everywhere except crossings of natural waterways	Median and Fence Line: Buried to 36 in. depth everywhere including natural waterways	Median and Fence Line: Buried to 36 in. depth everywhere including natural waterways
Regenerator			
Structure type	Standard surface enclosure ^b	Underground enclosure ^c	Enhanced surface enclosure ^d
Structure lightning/EMP protection	Standard protection ^e	Moderately enhanced protection ^f	Moderately enhanced protection ^f
Electronics lightning/EMP protection	Standard design ^g	Moderately enhanced design ^h	Moderately enhanced design ^h
Backup power	Battery, 8 hr. min.	Diesel with automatic kick-in/fuel for 14 days/underground	Diesel with automatic kick-in/fuel for 14 days/enhanced surface enclosure ⁱ

Table 17 (continued)

System Component	Enhanced System		
	Alternative 2	Alternative 3	Alternative 4
Cable			
Fiber type	Single mode/low phosphor	Single mode/low phosphor	Single mode/no phosphor
Type of strength member/sheathing	Nonmetallic strength member/metallic sheath	All dielectric	All dielectric
Installation provision	Median and Fence Line: Buried to 36 in. depth everywhere including natural waterways	Median and Fence Line: Buried to 48 in. depth everywhere including natural waterways	Median and Fence Line: Buried to 48 in. depth everywhere including natural waterways
Regenerator			
Structure type	Underground enclosure ^c	Underground enclosure ^c	Underground enclosure ^c
Structure lightning/ EMP protection	Moderately enhanced protection ^f	Significantly enhanced protection ^j	Significantly enhanced protection ^j
Electronics lightning/ EMP protection	Moderately enhanced design ^h	Significantly enhanced design ^k	Significantly enhanced design ^k
Back-up power	Diesel with automatic kick-in/fuel for 14 days/underground	Diesel with automatic kick-in/fuel for 14 days/underground	Diesel with automatic kick-in/fuel for 14 days/underground

^aDeveloped in conjunction with the Institute for Telecommunication Sciences (NTIA), Boulder, Colorado.

^bAbove-ground installation, reinforced foundation, and reinforced structure to withstand .44 magnum rifle discharged at 6 ft.

^cUnderground installation of the regenerator enclosure with a minimum of 36 in. earth covering.

^dMultiple reinforced structure to withstand 2 psi overpressure (i.e., steel-reinforced or equivalent).

^eEMC/EMI protection provided by attaching earth ground at cable entrance and exit. Any metallic parts such as the cable sheath, cable center strength member, and conduit should be grounded. Resistance to ground should be less than 3 ohms. If cable sheath or center strength member is used to provide power to the regenerator electronics, the system shall be protected with a spark gap device which will activate when subjected to lightning strike or EMP.

^fAdditional EMC/EMI protection provided with the requirement for ground-path current carrying capacity of 1000 amps for 1 sec. Resistance to ground should be < 2 ohms.

^gStandard EMC/EMI grounding and bonding techniques.

^hTransient Protection Devices (TPDs) implemented to protect/shunt induced currents to ground.

ⁱMultiple reinforced structure to withstand 2 psi overpressure plus surrounded by shield of .25 in. ferrous material tied to earth ground (for lightning/EMP protection).

^jRegenerator structure to include electromagnetic shield with field attenuation greater than 100 dB from 150 kHz to 2 GHz.

^kTransient hardened devices provided, especially at input and output of electronics stack (e.g., diode shunt protection, filters, ferrite cores, etc.); transient resistant circuit design practices used to reject or suppress unwanted signals (CMRR, filters, 1/2 wave shunt, etc.).

Table 18

COSTS OF ENHANCED INTERSTATE SYSTEMS
(\$000 per mile excluding ROW payment)

Cost Category	Current Commercial Practice	Level of Enhancement				
		Baseline	Alternative 1	Alternative 2	Alternative 3	Alternative 4
			Median			
Engineering	3.0	3.0	3.0	3.0	3.0	3.0
Cable procurement	16.6	16.6	16.6	19.3	23.6	28.2
Cable installation	10.0	12.5	12.5	12.5	13.5	13.5
Regenerators	15.2	19.8	16.6	19.8	19.8	19.8
Total	44.8	51.9	48.7	54.6	59.3	64.5
Incremental cost per mile	—	7.1	3.9	9.8	14.5	19.7
Fence Line						
Engineering	3.0	3.0	3.0	3.0	3.0	3.0
Cable procurement	16.6	16.6	16.6	19.3	23.6	28.2
Cable installation	16.0	16.0	16.0	16.0	17.7	17.7
Regenerators	15.2	19.8	16.6	19.8	19.8	19.8
Total	50.8	55.4	52.2	58.1	63.5	68.7
Incremental cost per mile	—	4.6	1.4	7.3	12.7	17.9

(Alternative 2) will add \$3000 per mile over and above the baseline hardening costs, while incorporating an all-dielectric cable and a 48-inch burial depth (Alternative 3) will add an additional \$7000 per mile to the baseline. Finally, utilization of a no-phosphorous fiber in addition to the all-dielectric cable and 48-inch burial depth (Alternative 4) will increase baseline costs by \$13,000 per mile.

DETERMINATION OF FUNDS AVAILABLE FOR INTERSTATE ROW PAYMENT

The amount of money available for rural Interstate ROW payment is equal to the difference between the total installed cost on the next best alternative and the estimated cost on the Interstate (exclusive of ROW payment). Based on our prior analysis of fiber installations on alternative ROW types, we saw that railroads, private land, and non-Interstate highways all cost roughly the same but that railroads showed marginally lower costs (\$57,000 per mile) than the others. Consequently, railroad ROW is selected as the next best alternative.

As indicated in Table 19, in the absence of any hardening whatsoever, there would be between \$6000 (fence line) and \$12,000 (median) per mile available for Interstate ROW payment. However, with baseline hardening, the amount available for ROW payment drops to between \$2000 (fence line) and \$5000 (median) per mile. The negative numbers associated with Alternative 2 (fence line) and Alternatives 3 and 4 indicate that the total (per mile) costs of the Interstate system incorporating the specified levels of hardening exceed the costs of the unhardened railroad ROW system.

It must be noted that these values are averages that do not capture unusual circumstances, whether favorable or unfavorable. Moreover, they assume that there is no competition between the two right-of-way types for the fiber-optics business. To the extent that there is competition (i.e., the railroads reduce the amount they request for ROW payment), the amount available for Interstate ROW payment will decrease.⁴

COST AS A FUNCTION OF THE NUMBER OF FIBERS PER CABLE

In addition to the location and hardening factors, costs will vary with the number of fibers per cable. The question of the number of required fibers per cable is a particularly relevant issue if, assuming there is a change in FHWA policy, a state government should require any firm installing a cable on Interstate ROW to be a carrier's carrier. Consequently, Fig. 12 illustrates how the costs of installing a cable in an Interstate median can be expected to vary as a function of the number of fibers per cable. As indicated, the cost per installed mile for a system with the specified characteristics can be approximated as follows:

$$\text{Cost per mile} = \$26,000 + \$2150 \text{ per fiber pair}$$

In other words, the incremental cost for each additional fiber pair is only about \$2200 per mile or about 5 percent of the cost of the baseline 24-fiber system. Note that the installed costs *per voice circuit mile* are relatively constant for fiber quantities greater than 24 and increase sharply *below* that quantity.

⁴Of the three alternative ROW types examined in this study, railroad ROW is the only one with any real potential for competing with the Interstate ROW. As shown in Table 14, non-Interstate highways normally have no leverage and private land, on average, has only about \$1000 per mile. Railroad ROW, on the other hand, has roughly \$12,000 per mile of leverage.

Table 19
FUNDS AVAILABLE FOR INTERSTATE ROW PAYMENT
(\$000 per mile)

Cost Category	Current Commercial Practice	Level of Enhancement				
		Baseline	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Median						
Cost on railroad (including ROW)	57	57	57	57	57	57
Cost on interstate (excluding ROW)	- 45	- 52	- 49	- 55	- 59	- 64
Amount available for Interstate ROW payment	12	5	8	2	-2	-7
Fence line						
Cost on railroad (including ROW)	57	57	57	57	57	57
Cost on interstate (excluding ROW)	- 51	- 55	- 52	- 58	- 64	- 69
Amount available for Interstate ROW payment	6	2	5	-1	-7	-12

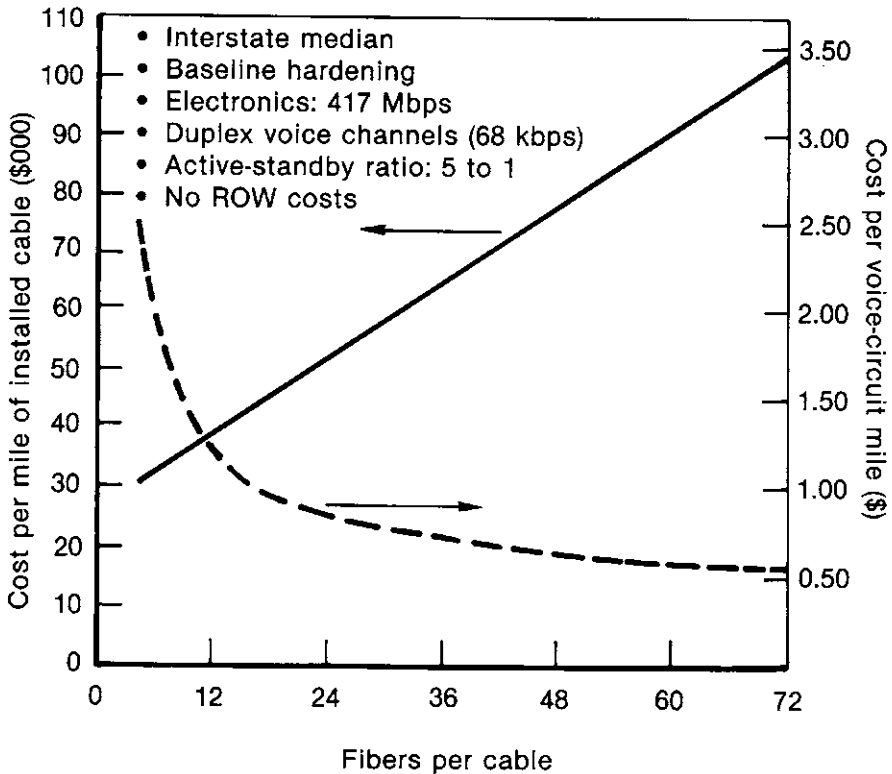


Fig. 12—Cost as function of the number of fibers per cable

SUMMARY

As shown below, the estimated funds available for Interstate ROW payment can vary by over \$20,000 per mile depending on the location in the ROW and the specified level of hardening. However, for what we think is a reasonable level of hardening, somewhere between \$2000 and \$5000 per mile should be available.

Level of Hardening	Location in Interstate ROW	
	Median	Fence Line
Current commercial practice	\$12,000/mile	\$ 6,000/mile
Baseline hardening	5,000/mile	2,000/mile
"Maximum" hardening (Alternative 4)	- 7,000/mile	- 11,000/mile

The key uncertainties with respect to these estimates are (1) the variability in the reported installation costs (at least a factor of five for each of the three non-Interstate ROW types)⁵ and (2) the relative costs of different fiber types (phosphorous content) and cable types over time (i.e., “learning” may result in the ability to produce a cable with a nonmetallic central strength member as cheaply as one with a metallic central strength member).

⁵See App. G.

VII. MARKET VALUE OF INTERSTATE HIGHWAY RIGHT-OF-WAY

In this section we examine major factors that determine the potential market value of Interstate highway right-of-way for installation of fiber-optics cables.

THE RELEVANT MARKET

The 43,000-mile Interstate highway system includes some 10,000 miles of limited-access highways within urban areas. In these larger cities, a variety of companies may seek access to highway system corridors to provide both urban and long-distance communications services over fiber-optics cables.

The subject of the present study is a potential national or regional backbone fiber-optics telecommunications network. We therefore limit our analysis to the 33,000 miles of Interstate highway that connect urban areas. Although the rights-of-way are also of potential value for other types of transmission and transportation, including possibly oil, gas, and coal slurry pipelines, we consider only the value of the ROW for use for fiber-optics cables.

To determine the value of these rights, the analysis must consider the major supply and demand factors in the relevant market.

Supply Factors

In this market, state governments hold title to the Interstate highway ROWs and are the single suppliers of access to these highways. However, this monopoly does not necessarily give the states a great deal of market power, for in most cases there are substitutes for these rights. Typically, telecommunications carriers can consider several alternative routes over which they could construct transmission facilities to connect the urban areas, and also have some choice of the type of facility to use.

To date, carriers have constructed fiber-optics systems on ROW acquired along railroad lines, state highways, and on private and public land. The strategy followed by any one carrier reflects its particular opportunities. For example, AT&T has installed fiber-optics cables along ROWs it had previously acquired for its coaxial cable routes. Newer carriers have frequently obtained rights from railroads. Special situations can also be important. In California, the state aqueduct

system provided an attractive route linking much of the state, and in several western states federal lands are significant.

Demand Factors

The demand for ROW needs to be examined in terms of the larger market for telecommunications. The intercity commercial carriers produce telecommunications services using long-distance transmission facilities to send messages between urban areas and connect electronic switching and control equipment located throughout the networks. Right-of-way for these facilities is just one of the necessary factors of production.

What a carrier will potentially pay to obtain ROW will depend on the demand for the telecommunications service in the final market and the conditions of production. The economic demand for ROW derives from the final demand for telecommunications services—principally switched network and private line services, and especially digital service. Although final demand for telecommunications services arises in all sectors of the economy, it will be greatest in markets connecting cities that have large populations or are intermediate links between more distant major markets, or have specialized telecommunications requirements and lack good alternatives to digital service.

VALUE OF THE RIGHT-OF-WAY

The value of a right to use an Interstate highway for a fiber-optics cable is the *maximum* payment that could be obtained by the supplier for permitting its use on the stated terms. (In order to value ROW consistently in this discussion, the access terms will exclude any requirement to provide services to the ROW owner or to construct the system to NSEP standards. These factors can be considered once the maximum value has been determined.)

The maximum amount can, in principle, be assessed by determining how much a carrier's profit would increase if it could obtain that right without payment and construct a fiber-optics link on the ROW, versus the profit it would have if the right were not available. In markets where several carriers wish to obtain access, the value of the ROW is the maximum payment that could be obtained from any single carrier or, if greater, the total of ROW payments that could be obtained by offering the rights to all carriers.

For a carrier, a fiber-optics cable located on an Interstate highway provides one method of producing telecommunications service in the

intercity market in question. Given the prices of all other factors, the maximum price it would pay for this ROW is the increased profit that it would obtain by using this ROW as compared with the alternative of producing service by using the next most profitable method. If the carrier actually paid the maximum price, the supplier would capture all of the potential value of the ROW, leaving the carrier indifferent between constructing its facilities on the highway and elsewhere.

ROW Alternatives

If there are no effective substitutes for the highway ROW—if it is truly not possible to provide the communication service without fiber-optics cables along the highway—then the maximum price would be the entire economic profit that the carrier could obtain by supplying telecommunications service in that market (that is, its profit in excess of the normal return on invested capital).

However, in most cases carriers have several attractive alternatives to using a highway ROW. In these instances the maximum ROW price is the increase in profit that the ROW makes possible, as compared with only the profit that would be earned from the next-best method of producing the service.

Frequently, carriers will have several alternatives to fiber-optics cables on the highway. These options include:

- Another ROW where fiber-optics cable can be installed. The ROW may be either more or less attractive when compared with the Interstate highway option.
- Another type of transmission facility—microwave radio, coaxial cable, or communications satellite.
- Transmission capacity leased from another carrier.

The attractiveness of these options, both Interstate highway ROW and other alternatives, is affected by the costs of construction, the time required to obtain permits and rights-of-way, the expected costs of maintenance, as well as any access to new markets offered by the route. In at least some markets, Interstate highways are expected to have lower costs of construction and lower maintenance costs than other alternatives.

Illustrative Cases

Case 1. A carrier is seeking to extend its network or to add digital transmission services to its existing analog network. Currently, it has no link between urban areas A and B. The Interstate highway connecting those areas is one potentially attractive right-of-way. Impro-

tant alternatives are obtaining ROW from one of the several railroads that connect these areas, and obtaining rights for laying cable on state roads. Still another possibility is to build this link of the network with microwave transmission, acquiring rights for locating the microwave repeater facilities every 20 miles or so.

Case 2. The carrier's network currently includes a fiber-optics cable between A and B located on a railroad ROW. The carrier anticipates growing demand for service and needs to expand transmission capacity. Its principal alternatives are to reinforce the existing facilities by laying a second cable or by upgrading the existing electronic equipment, or to build a new facility on the highway ROW.

Case 3. The carrier has negotiated a ROW agreement between A and B with a railroad or other ROW owner but has not yet begun construction. This case is similar to Case 1, except that some costs of the nonhighway ROW have already been incurred, reducing the value of highway ROW.

Factors Influencing ROW Value

Right-of-way values will vary from market to market. Some highway segments will be of little or no value; others could be quite attractive to several carriers. There is no single, representative per-mile value for Interstate highway rights-of-way. However, the following general factors will influence values in all markets:

- Interstate highway ROW values will be higher for highway segments that connect major cities with high telecommunications volume, as well as segments linking more distant urban areas. Values will also be high for highway ROW within the metropolitan areas themselves.
- Values will be higher when a carrier does not yet have a fiber-optics facility in the market, and when the highway ROW offers significant cost or reliability advantages over alternatives.
- Values may be minimal in markets where carriers have already installed fiber-optics facilities. Even if highway rights-of-way offered lower costs on an initial comparison, the incremental costs of expanding capacity on an existing ROW are likely to be lower than the total costs of constructing a new facility on a highway.

DIVISION OF ROW VALUES

From the perspective of a state ROW owner, the value of the ROW is the maximum payment that could actually be obtained. This

maximum value of the Interstate highway ROW can be divided in four ways:

1. Lease payments by the carrier to the state.
2. Telecommunications (or other) services supplied by the carrier to the state.
3. Lower production costs to the carrier, resulting in higher profits or lower telecommunications prices.
4. Additional carrier construction costs for NSEP enhancements.

To date, ROW leasing arrangements on state-owned toll roads have consisted of various combinations of the first three.

In principle, a state could negotiate for the maximum possible payment and extract the total value of the ROW from the carrier in the form of fee payments or in-kind services. The state's market power, as the ROW owner, varies with the scarcity of the particular ROW. Market power will be highest in markets with poor alternatives, and weak in markets where fiber-optics facilities have already been constructed. The market power of other ROW owners (railroads and private and federal land owners) is affected similarly.

At the other extreme, the state could make the ROW available at a nominal fee, with no requirements for initial services or enhancements. In this case, all of the value would be transferred to the carrier.

A requirement that carriers construct the fiber-optics system to include NSEP enhancements will increase carrier costs and reduce the attractiveness of the Interstate ROW compared with other alternatives. This added cost can be regarded as a fourth way of dividing up the value of using a highway segment; thus, NSEP requirements will reduce the maximum lease payments that a state could otherwise realize.

ASSESSING THE ADEQUACY OF POTENTIAL INTERSTATE ROW PAYMENTS

Toll Roads

Although the Interstate highway system has not generally been open to fiber-optics systems, in a few states carriers have obtained access to ROW for segments of limited-access toll roads and turnpikes. Table 20 summarizes the ROW fees that have been paid. Compensation may consist of a one-time fee, for a 20 to 25 year period with provision for renewal, or of an annual fee.

Table 20

RIGHT-OF-WAY FEES ON TOLL ROADS AND OTHER FACILITIES

State	Facility Type	Location	Environment	Year	Miles	Fee per Mile (\$)		Notes
						Annual	One-Time	
Turnpikes and Toll Roads								
Florida	Turnpike	Median	Rural	1985	104	[736]	4600	25 years?
Illinois	Toll road	Edge	Suburban	1984	25	[1600]	10,000	23 years
Indiana	Toll road	Median	Rural	1985	136	1800	[11,300]	+ fiber pair
Kansas	Turnpike	Edge	Rural	1985	179	NA	NA	+ rights to use
Massachusetts	Turnpike	Median	Urban	1983	33	~ 7000	[43,800]	+ duct for turnpike
		Median	Urban	1986	86	5000-7500	[31,500-46,900]	+ duct for turnpike
New York	Thruway	Fence	Suburban	1986	6	[5280]	33,000	20 years
Ohio	Turnpike	Median	Rural	1985	222	1600	[10,000]	+ fiber pair (company #1)
		Median	Rural	1985	17	1850	[11,600]	
State Highways								
Georgia	Highway	Edge	Rural	1984	106	2000	[13,000]	rural, 5 companies
California Aqueduct								
California	Aqueduct	NA	Rural	1985	400	2850	17,800	25 years 3 fiber pairs + system

NOTE: The actual fee structure (annual or one-time) in each state is represented by the unbracketed value. A corresponding annual or one-time value is provided in brackets and is determined on the basis of a 20-year life and a 15 percent discount rate.

Under some agreements, the carrier provides facilities or services as partial compensation. In the case of the California aqueduct, the carrier is supplying the water authority with specialized communications and control equipment for operation of the aqueduct system. In other agreements, a carrier may be required to reserve fiber capacity for state use or to install ducts for future leasing.

The wide range in per-mile fees represented by these agreements indicates the variety of market conditions that do occur, and that toll-road fees have been negotiated on a case-by-case basis. In New York, for example, the recently concluded thruway agreement ran to \$33,000 per mile. However, it covers just 6 miles and the carrier's alternative route, along a heavily traveled suburban state road, would have resulted in considerably higher construction costs. In Georgia, the state has set a uniform fee of \$2000 per mile for all state highways in non-urban areas with significant traffic volume.

The toll-road facilities that are probably the best analogies for rural Interstate median are as follows:

<u>One-time Charge</u>	
Florida	\$ 4,600
Ohio	10,000
Indiana	11,300

Although specific circumstances vary somewhat from road to road, payments for the two midwest roads are in the \$10,000 per mile range (one-time charge), whereas the payment for the one southeast road is roughly \$5000 per mile. Thus, the *calculated* amount available for rural Interstate median (\$5000 for baseline enhancement) matches the minimum toll-road payment (Florida) but is only about one-half the norm (Ohio and Indiana).

It is likely that the fees for the already-constructed toll-road ROWs represent values that are significantly higher than the average value of ROW on all Interstate highways. In most cases, carriers have negotiated for and constructed only portions of all toll-road mileage; those segments that have been built are likely to represent markets in which alternative locations are more costly to construct or otherwise less attractive. Thus, these rates probably represent the maximum values that states could obtain for selected Interstate highway segments. Per-mile values for rights averaged over the full Interstate highway system are likely to be considerably lower.

Comparison with Average Private Land Payments

In addition to the toll-road payments, another useful point of comparison is the payments made for private land adjacent to rural Interstates. Unfortunately, such information was not readily available. However, we were able to develop estimates of *average* rural land payments for the United States as a whole, as well as for the states of Indiana and Ohio.¹ The values are as follows:

	<u>\$/linear mile</u>
Indiana	1,850
Ohio	1,650
United States	990

Thus, the amount available for rural Interstate median payment is about five times the average U.S. rural land payment and about 2-1/2 times the average rural land payment in the two midwest states.

Do the ROWs Offer a Sufficient Cost Advantage?

This question can be addressed from two viewpoints—that of the carriers and that of the states. From the carriers' perspective, the answer is yes, provided the required ROW payment is, on average, \$5000 per mile or less. Bear in mind, however, that this \$5000 is a value that will drop off if (a) installation in the median is prohibited, (b) greater levels of hardening are required, or (c) the railroads decide to compete for the fiber-optics business.

Unfortunately, we cannot provide as definitive an answer for the state perspective. We showed above that the amount available for Interstate median ROW payment matched the minimum observed toll-road payment (in Florida) but was only about one-half the "typical" toll-road payment (in Indiana and Ohio). However, we also concluded that these rates undoubtedly represent *maximum* values that states can obtain for *selected* (high-demand) Interstate segments. At the other end of the spectrum, we estimated that the amount available for Interstate median ROW payment was still roughly five times the average U.S. payment for easements on private rural land. Thus, ROW payments of between \$1000 and \$5000 per mile appear feasible, but whether or not this is sufficient to induce states to grant access to

¹One-time payments for easements on private land typically run from 50 to 70 percent of the land value. Our calculations are based on the higher 70 percent factor and an assumed 20-ft construction corridor (2.4 acres per linear mile).

their Interstate ROW is a question involving a number of fairly subjective factors. For example, states disinclined to open their ROWs for reasons of safety and administrative/policing costs may only alter their positions if the payment is sufficiently high. On the other hand, there are several reasons why a state might be willing to accept a relatively lower monetary payment than otherwise, including:

- Value placed on having a hardened link in the state (for natural disasters)
- Value placed on contributing to national security
- Value placed on promoting economic growth
- Value placed on in-kind payments (e.g., dedicated fiber pair)
- Decline in other revenue sources

In summary, there probably is a sufficient cost advantage from the perspective of both the carriers and the states. However, this conclusion is highly sensitive to assumptions about location in ROW, level of required hardening, potential competition from the railroads, and how strongly a state feels about limiting its Interstates to highway uses only.

ASSESSING CARRIER INTEREST IN PROPOSED EXCHANGE CONCEPT

Fiber-optics cable is the preferred transmission medium for intercity telecommunications today, and major telecommunications carriers have been installing high-capacity links at a rapid rate. In new markets carriers are constructing only fiber-optics facilities, except in unusually difficult terrain.

AT&T and its major intercity competitors initially built microwave radio systems to connect the high-demand routes between the largest cities. In these markets, too, fiber-optics cable is now being installed to expand capacity and in some cases to replace older microwave installations.

The effective capacity of a single fiber-optics cable has been expanding rapidly. Current installations have bandwidths of 417 to 1700 Mbps. Improvements in electronic components that modulate and detect fiber-optics signals are expected to continue to expand the capacity of installed cables. Newly constructed systems will also be able to achieve higher bandwidths by operating at shorter wavelengths.

The rapid construction of fiber-optics systems in the long-haul markets has led to concern that the industry is reaching a state of overcapacity, and several carriers have stretched out construction schedules or cancelled planned routes.

At this time, most links in a national backbone network that would connect the major U.S. urban areas by fiber optics have already been built by at least one carrier, are under construction, or are in the ROW acquisition process (see Fig. 3). The routes that remain unbuilt are those with lower demand, smaller populations, and markets that are not yet served by AT&T's long-haul competitors.

The key implication is that the demand for new intercity ROW for fiber-optics systems is declining as carriers complete construction of already-planned routes. Although communications demand will undoubtedly continue to grow, technological advances that expand the capacity of already-installed systems are expected to keep ahead of higher demand for some time. As a result, the public policy opportunity to influence a nationwide backbone fiber-optics network consists of a shrinking window.

EFFECTS ON COMPETITION IN THE TELECOMMUNICATIONS INDUSTRY

The availability of Interstate highway ROWs for fiber-optics cables will tend to promote increased competition in telecommunications.

In many states, more than one carrier is likely to seek access to the Interstate highway. The competition among two or more carriers to obtain the use of this resource will tend to increase the market power of the state, as supplier of the ROW, and result in transferring a larger portion of the maximum value of the ROW to the state.

In offering the ROW for lease, states have several options:

- Lease the ROW to highest-bidding carrier on an exclusive basis.
- Lease the ROW to all carriers bidding above a specified amount.
- Require the highest-bidding carrier to sublease capacity or duct space to other carriers.
- Require the highest-bidding carrier to construct ducts for the state that could subsequently be leased to other carriers.

The availability of a segment of Interstate ROW will increase the number of alternatives available to carriers. This increased supply of a potentially scarce resource will tend, if anything, to reduce the market power of the carriers already supplying that market and thus to promote competition.

Beyond the competitive effects in a particular state, the availability of Interstate highway ROWs could lead to a more competitive telecommunications industry structure. New ROW may enable additional

carriers to enter some intercity markets more readily than they are currently able to do by acquiring rights from state highways, railroads, and private land.

It is also possible that access to these ROWs would enable a new group of carriers to enter the intercity markets for the first time. Under the terms of the Department of Justice—AT&T Consent Decree, the Bell Operating Companies (BOCs) are now prohibited from offering longer-distance interurban services. At least some of those companies, however, are actively seeking to have this restriction lifted. The BOCs do not now own intercity transmission facilities and a change in the consent decree would lead to an increase in the demand for ROW.

Finally, the availability of ROW on urban portions of Interstate highways could also affect telecommunications competition in local metropolitan areas. These potential fiber-optics cable corridors could be attractive to intercity carriers and other communications companies seeking to "bypass" local exchange telephone companies and provide business customers with direct access to long-haul network services.

STATE MANAGEMENT OF A ROW OFFERING

States offering Interstate highway ROWs to telecommunications carriers will confront issues similar to those that arise in selling and leasing rights to other public resources such as minerals and timber.

An Interstate highway segment could be offered on exclusive terms. This approach minimizes both the state agency's administrative involvement and the construction activity on the highway.

Leasing terms could require the winning carrier to sublease capacity or to construct cable ducts and lease duct space in which another carrier would install its own cable without undertaking new construction. However, establishing rates for services supplied by one carrier to other carriers could be quite difficult. Experience in related areas, such as attachment of cable-television coaxial cable to telephone utility poles, has been highly contentious and resulted in protracted regulatory and legal proceedings.

However, if the leasing terms required the winning carrier to construct ducts for state use, the state could itself then lease this duct capacity to other carriers. This approach avoids the difficulty of regulating carrier-set rates. In either approach, a duct requirement would itself increase construction costs.

The ROW could be offered on a nonexclusive basis, with additional carriers permitted to lease ROW and construct systems over time.

This approach has the potential of generating greater total lease revenue to the states, but requires more management. The risk of a cable cut during construction by a subsequent carrier may reduce the attractiveness of the ROW to bidding carriers.

Other factors will also be relevant to a state's ROW offering. The lease terms could require that a complete, border-to-border, fiber-optics cable be constructed. This provision would be consistent with federal objectives of a complete, NSEP-enhanced backbone network, but could deter building by a carrier with established capacity seeking only to extend an existing route.

States could require in-kind communications services in lieu of some or all ROW fees.

Because carriers initially construct fiber-optics systems with excess capacity, in anticipation of growing demand, the marginal cost to the carrier of providing a fiber pair to the state may be lower than the price the state would have to pay for equivalent capacity. However, this capacity may not be readily usable by the state without additional specialized equipment.

VIII. FINDINGS

CONCERNS OF HIGHWAY OFFICIALS

Highway officials have long had serious misgivings with respect to permitting utilities to longitudinally occupy Interstate highway ROW. Foremost among their concerns are the related issues of safety and traffic flow. Others include: (1) creation of additional costs for state highway authorities in terms of administering permits and policing installation and maintenance activities; (2) possible responsibility for paying relocation costs should it be necessary to move the utility; and (3) possible responsibility for liability should the utility be damaged in the course of road maintenance or improvement.

When taken in the context of the full spectrum of possible utility installations, these concerns clearly have merit. However, with respect to the specific case of fiber-optics installations, we feel that the concerns have little, if any, foundation. Based on reasonably analogous toll-road experience, we see no reason that the relocation and administrative cost issues as well as most liability questions cannot be handled by contractual means. Additionally, it is our opinion that fiber-optics installations in *rural* areas would have minimal effect on Interstate safety and traffic flow.

Yet despite the minimal effects fiber installations are likely to have, highway officials remain opposed to their placement in Interstate ROW. Some have had bad experiences with utilities in the past (i.e., not following agreed-upon installation procedures) and simply do not trust any of them. But it is our opinion that the bulk of the opposition results from the fact that highway officials view fiber optics as a Trojan horse—if fiber is let on, then all utilities will have to be let on, and the safety, traffic flow, and administrative headaches will really start.

The question then becomes one of whether access can be limited to fiber optics. As a matter of law, discrimination among utilities for access to a government benefit requires a “rational basis” (Equal Protection Clause of the Constitution). But the methodology by which courts look for such a rational basis is remarkably generous to the government decisionmaker. Generally speaking, so long as fiber-optics utilities have *any* advantage over other utilities with respect to *any* single criterion—or any *combination* of criteria—a policy that limits access to hardened fiber optics would not be held to violate Equal Protection.

In this regard, we have heard several suggestions on how fiber-optics utilities might be distinguished from other utilities. *National security* is one possibility, although a number of utilities—oil and natural gas transmission pipelines, power transmission cables—can make claims to their national security necessity. *Safety* appears to have a firmer foundation. Utilities that transport a volatile or hazardous medium (such as oil and gas pipelines and power transmission cables) might be excluded, as well as utilities which, if ruptured, could undermine the stability of the roadway (water, sewer). Additionally, relative to other utility types, fiber-optics *installation* is fairly fast and unobtrusive and *maintenance* requirements are minimal.

In summary, while we cannot state with absolute certainty what the ultimate outcome of judicial challenges to such distinctions would be, we nevertheless believe a strong case can be made for limiting access to Interstate ROW to fiber optics.

FEASIBILITY OF BARTER CONCEPT

As discussed at the end of Sec. II, there are four questions that need to be answered affirmatively if the proposed “access-for-hardening” concept is to result in a hardened fiber-optics backbone:

1. Can complete ROW continuity be obtained for the entire backbone network?
2. Can minimum standards of hardness be imposed as a condition of access? And if so, by whom?
3. Is there really a cost advantage on the Interstates (relative to the next best alternative) sufficient to support the cost of enhancements and the ROW payments asked by the states?
4. And finally, even if all the other conditions are met, will all the backbone routes be financially attractive to the carriers?

Our answers to these questions are summarized below.

Can Backbone ROW Continuity Be Obtained?

We examined three generic approaches (five specific options) by which ROW continuity might be obtained:

- Pursuing *voluntary* federal/state cooperation;
- *Inducing* state cooperation by tying federal highway aid to a state’s granting of access; and

- *Compelling* state cooperation through: (a) the congressional power of eminent domain; (b) certain authorities granted by Congress to specific agencies within the Executive branch (FHWA, FEMA, and NCS); or (c) Presidential war and emergency powers.

Two of the five specific options listed above can be summarily dismissed—we could find no legal basis for either the President or agencies within the Executive branch compelling states to grant access to their Interstate ROW. Of the remaining options, voluntary federal/state cooperation is certainly the most politically attractive. However, we believe that the chances of getting a full backbone network using this approach are small. This conclusion is based on the strongly negative attitude emerging from the AASHTO survey of state highway departments and the relatively noncommittal attitude emerging from the survey of state governors. On the other hand, from a practical standpoint, the two remaining options (tie to federal highway aid and condemnation of required easement) are both quite likely to produce the necessary continuity. However, both of these options require congressional approval and, unfortunately, we cannot say what type of political support they might enjoy.

Can the Carriers Be Required to Enhance Systems?

All states have the authority to impose construction standards for projects using state-owned property and therefore have the power to contract for NSEP enhancements. The real difficulty here is not with respect to the states' authority to impose standards but rather persuading *all* states comprising the backbone network to impose a minimum level of hardening as a *quid pro quo* for utility access. Even if all the states along the backbone route grant access (which is highly unlikely), those that do so grudgingly may promote relatively high minimum standards in order to discourage carrier interest. But there will also be other states that will want to maximize revenues or encourage fiber installation and will therefore try to keep NSEP standards as low as possible. Consequently, reaching agreement among the states is likely to be a formidable task.

Because the states own the Interstate rights-of-way, the federal government cannot impose NSEP enhancements on private carriers through any existing legal authority. However, Congress could provide the states a strong incentive to require NSEP enhancements by conditioning federal highway aid on state acceptance of such standards. Or, Congress could exercise its power of eminent domain to ensure that any Interstate fiber installations were enhanced.

Do the ROWs Offer a Sufficient Cost Advantage?

This question can be addressed from two viewpoints—that of the carriers and that of the states. From the carriers' perspective, the answer is yes, provided the required ROW payment is, on average, \$5000 per mile or less (baseline enhancement). Bear in mind, however, that this \$5000 is a value that will drop off if (a) installation in the median is prohibited, (b) greater levels of hardening are required, or (c) the railroads decide to compete for the fiber-optics business.

We cannot provide as definitive an answer for the state perspective. Previously, we showed that the amount available for Interstate median ROW payment matched the minimum observed toll-road payment (in Florida) but was only about one-half the "typical" toll-road payment (in Illinois, Indiana, and Ohio). However, we also concluded that these rates undoubtedly represent *maximum* values that states can obtain for *selected* (high-demand) Interstate segments. On the other end of the spectrum, we estimated that the amount available for Interstate median ROW payment was still roughly five times the average U.S. payment for easements on rural land. Thus, ROW payments of between \$1000 and \$5000 per mile appear feasible, but whether this is sufficient to induce states to grant access to their Interstate ROW is a question involving a number of fairly subjective factors. For example, states disinclined to open their ROWs for reasons of safety and administrative/policing costs may alter their positions only if the payment is sufficiently high. On the other hand, there are several reasons why a state might be willing to accept a relatively lower monetary payment, including such abstract concepts as contributing to the national security and promoting economic growth.

In summary, there probably is a sufficient cost advantage from the perspective of both the carriers and the states. However, this conclusion is highly sensitive to assumptions about location in ROW, level of required hardening, potential competition from the railroads, and how strongly a state feels about limiting its Interstates to highway uses only.

Will the Carriers Find the Proposal Economically Attractive?

Fiber-optics cable is the preferred transmission medium for intercity telecommunications today, and major telecommunications carriers have been installing high-capacity links at a rapid pace. At this time, most links in a national backbone network that would connect the major U.S. urban areas by fiber optics have already been built by at least one carrier, are under construction, or are in the ROW acquisition process.

The routes that remain unbuilt are those with smaller populations and lesser demands. Additionally, the effective capacity of a single fiber-optics cable has also been rapidly expanding. Current installations have bandwidths of 417 to 565 Mbps. Improvements in electronic components that modulate and detect fiber-optics signals are expected to continue to expand the capacity of installed cables by a factor of at least 15.

The key implication is that the demand for new intercity ROW for fiber-optics systems is declining as carriers complete construction of already-planned routes. Although communications demand will undoubtedly continue to grow, technological advances that expand the capacity of already-installed systems are expected to keep ahead of higher demand for some time. As a result, the public policy opportunity to develop a more survivable backbone fiber-optics network is rapidly being foreclosed.

Summation

As indicated in Table 21, without congressional action the conclusions regarding the two institutional issues (ROW continuity and enhancement requirement) are fairly pessimistic. These difficulties could be largely overcome, however, if Congress could be persuaded to pass legislation either: (1) tying federal highway aid to a state's acquiescence in the development of a hardened fiber-optics telecommunications backbone, or (2) exercising its power of eminent domain. Nevertheless, possible congressional action addresses only the institutional obstacles; it cannot guarantee a cost advantage or carrier interest. As a result, it is our opinion that the proposed barter concept is unlikely to result in anything other than a number of isolated segments irrespective of any congressional action.¹ However, even these isolated segments could help increase the post-attack connectivity of the network by (a) providing the system with some hardened, and therefore, more survivable links, and (b) potentially increasing the redundancy in the network (to the extent that interstate routes supplement rather than substitute for other ROW routes).

¹It is probable, however, that there would be a larger number of isolated segments with congressional action than without.

Table 21
KEY FEASIBILITY ISSUES

Issue	Feasibility	
	Without Congressional Action	With Congressional Action
Can backbone ROW continuity be obtained?	Very doubtful	Very likely if tied to federal highway aid or if power of eminent domain exercised
Can the carriers be required to enhance the systems?	Yes, although voluntary agreement among states on uniform standard will be difficult	Very likely if tied to federal highway aid Yes if power of eminent domain is exercised
Do the ROWs offer a sufficient cost advantage?	In general, yes; but subject to wide variation	In general, yes; but subject to wide variation
Will the carriers find the proposed economically attractive?	In some, but not all, markets	In some, but not all, markets

ADDITIONAL FEDERAL OPTIONS FOR OBTAINING HARDENED FIBER-OPTICS BACKBONE

Our analysis has led us to conclude that a full hardened backbone using the proposed barter concept is unlikely. However, if the federal government is interested in obtaining a backbone, the following options are available.

- Pursue the barter concept, see what the results are after a year or two, and then fill in any gaps. Potentially, gaps could be filled in by (a) directly subsidizing the incremental cost of hardening on planned but not-yet-built commercial routes (using either Interstate or non-Interstate ROW) or (b) constructing hardened government-owned segments.
- Alternatively, the idea of using Interstate ROW could be dropped altogether in favor of directly subsidizing the hardening of systems using non-Interstate ROWs, probably through some combination of retrofitting in-place installations and

incrementally hardening planned but not-yet-built fiber segments. Assuming a backbone could be pieced together from planned but not-yet-built routes, the total cost of subsidy would probably be on the order of \$100 million ($10,000 \text{ miles} \times \$7000 \text{ per mile (baseline enhancement)} \times 1.50 \text{ contingency factor}$).

- Another option, and one likely to be unpopular with the carriers, is to construct a federally owned backbone. Excluding switches and local distribution, such a backbone would probably cost on the order of \$1 billion ($10,000 \text{ miles} \times \$60,000 \text{ per mile (baseline enhancement)} \times 1.70 \text{ contingency factor}$). However, part of these initial costs would be offset by reduced annual expenses for purchased telecommunication services.
- Finally, the federal government could encourage voluntary hardening by giving preferential treatment in the awarding of telecommunications services contracts to carriers whose networks (or portions thereof) are constructed to certain minimum standards.

Appendix A

BACKGROUND ON NCS AND FHWA

NCS

Most of the following material has been taken verbatim from the brochure entitled *National Communications System: Organization and Functions*, prepared by the Office of the Manager, National Communications System, Washington, D.C., August 1, 1983.

Establishment

The National Communications System was established on August 21, 1963, by Presidential Memorandum to the Heads of all Departments and Agencies, entitled "Establishment of the National Communications System." The NCS is a confederation in which federal departments and agencies participate with their telecommunications assets to provide essential communication services for the federal government under all conditions ranging from normal day-to-day situations to national emergencies and international crises, including nuclear attack. The principal assets of the NCS include telecommunications networks of the Departments of State, Defense, Interior, Commerce, Energy, and Transportation (which includes networks of the Federal Aviation Administration and the U.S. Coast Guard), the Federal Emergency Management Agency, the U.S. Information Agency, the National Aeronautics and Space Administration, the General Services Administration, and the Central Intelligence Agency.

The Concept: A Coherent National Telecommunications System

The assets of the NCS member organizations comprise the bulk of the long-distance telecommunications resources of the federal government. Telecommunications facilities are planned, funded, and operated by the parent agencies to satisfy their respective mission requirements; however, through joint planning, standardization, and other coordinated management activities of the NCS, they are available to satisfy national requirements transcending those of the individual operating agencies. The objective is to ensure that essential federal

telecommunications resources are improved progressively and can be interoperated so that the aggregate functions as a coherent system under emergency conditions.

Organization

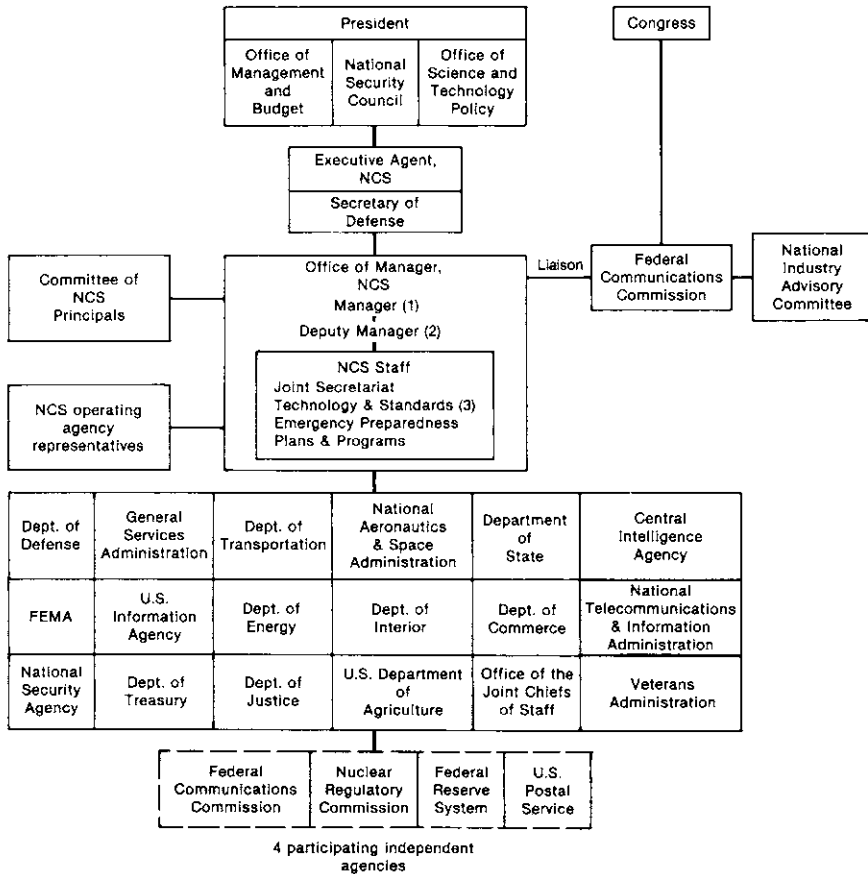
Executive Order 12472 ("Assignment of National Security and Emergency Preparedness Telecommunications Functions") designates the Secretary of Defense to serve as the Executive Agent for the National Communications System (see Fig. A.1). Functioning within the guidance provided by the National Security Council, the Executive Agent, NCS, is responsible for ensuring that unified operations and technical planning are conducted to afford a highly effective and responsive system to meet the needs of the federal government.

In turn, the Secretary of Defense has designated the Director of the Defense Communications Agency (DCA) to serve as the Manager of the NCS. In order to carry out the NCS management responsibilities, an Office of the Manager, NCS, was established and is collocated with the Headquarters of the Defense Communications Agency and receives administrative and logistical support from the Defense Communications Agency.

The major functions delegated to the Manager, NCS, by the Executive Agent, NCS, include those pertaining to coordination, planning, standards, test, and evaluation. Current funding for studies and analyses is roughly \$27 million. Personnel support for the office is provided by the federal departments and agencies of the confederation, i.e., individuals are detailed from their parent organizations to the NCS staff for a minimum full-time duty tour of two years (current staffing is approximately 80 people).

The operating agencies of the NCS play a central role in the formulation of telecommunications policy and the solution of mutual problems by means of representation in NCS study groups, ad hoc committees, and permanent committees formed by the Manager, NCS. Depending on the nature of the task, the operating agencies provide personnel with the needed skills to serve on the working groups and committees along with members of the Manager's permanent staff.

There are two groups of representatives from the NCS member agencies who perform continuous advisory and liaison functions. The NCS operating agencies designate an individual to serve as the NCS Principal to the Executive Agent, NCS. This group meets periodically with the Manager, NCS, to review the status of NCS major projects and activities and to discuss major telecommunications issues of interest to the federal community. The second group consists of



(1) Director, DCA serves as Manager, NCS.

(2) First line management position that is exclusively NCS.

(3) Office with responsibility for RAND project

Fig. A.1—NCS organization.

individuals designated by their agencies to serve as representatives to the Manager, NCS, to provide day-to-day liaison with their respective agencies. The representatives maintain close contact with the staff of the Manager, NCS, serve on NCS working groups and committees, and keep their respective NCS Principals informed of ongoing NCS activities.

FHWA

Organizationally, the FHWA is part of the Department of Transportation. The mission of the FHWA is to administer the federal-aid highway program whose purpose is to construct and improve the nation's urban and rural highway systems.

Federal-Aid Systems: Mileage and Travel

Federal-aid systems are segments of state and local mileage eligible for funding through the federal-aid highway program. The federal-aid systems include 21.5 percent of total road and street mileage but carry nearly 81 percent of total travel (see Table A.1).

Organization

The FHWA organizational structure is depicted in Fig. A.2. Responsibility for developing Interstate ROW policy resides within the Railroad, Utilities and Program Branch of the Office of Engineering of the Associate Administrator for Engineering and Program Development. Responsibility for the RAND contract lies within the Office of the Secretary of Transportation (Telecommunications Division of the Office of Management Systems of the Assistant Secretary for Administration).

Source of Funds

Expenditures on federal-aid highway programs are financed by the Highway Trust Fund. The operation of the Trust Fund requires that federal highway expenditures not exceed revenues. The sources of Trust Fund receipts are shown in Table A.2. As shown, roughly 80 percent of receipts came from motor fuel taxes.

Table A.1
FEDERAL-AID SYSTEMS: MILEAGE AND TRAVEL

System	Rural	Urban	Total	Percent
Mileage (Thousands)				
Federal-aid				
Interstate (arterials)	33	10	43	1.1
Primary (arterials)	226	31	257	6.6
Urban (arterials & collectors)	—	137	137	3.5
Secondary (collectors)	398	—	398	10.3
Total	657	178	835	21.5
Non-federal aid	2,561	484	3,045	78.5
Total	3,218	662	3,880	100.0
Vehicle-Miles of Travel (Billions)				
Federal-aid				
Interstate (arterials)	145	191	336	20.4
Primary (arterials)	270	213	483	29.3
Urban (arterials & collectors)	—	360	360	21.8
Secondary (collectors)	148	—	148	9.0
Total	563	764	1,327	80.5
Non-federal aid	138	184	322	19.5
Total	701	948	1,649	100.0

SOURCE: *Our Nation's Highways: Selected Facts and Figures*, U.S. Department of Transportation (FHWA, Office of Highway Planning), HHP-41/7-85 (35M)/E, 1985, p. 5.

Federal Aid Highway Program Authorization

As indicated in Table A.3, roughly 80 percent of federal aid is for road construction and rehabilitation (the two Interstate programs and the primary, secondary, and urban programs).

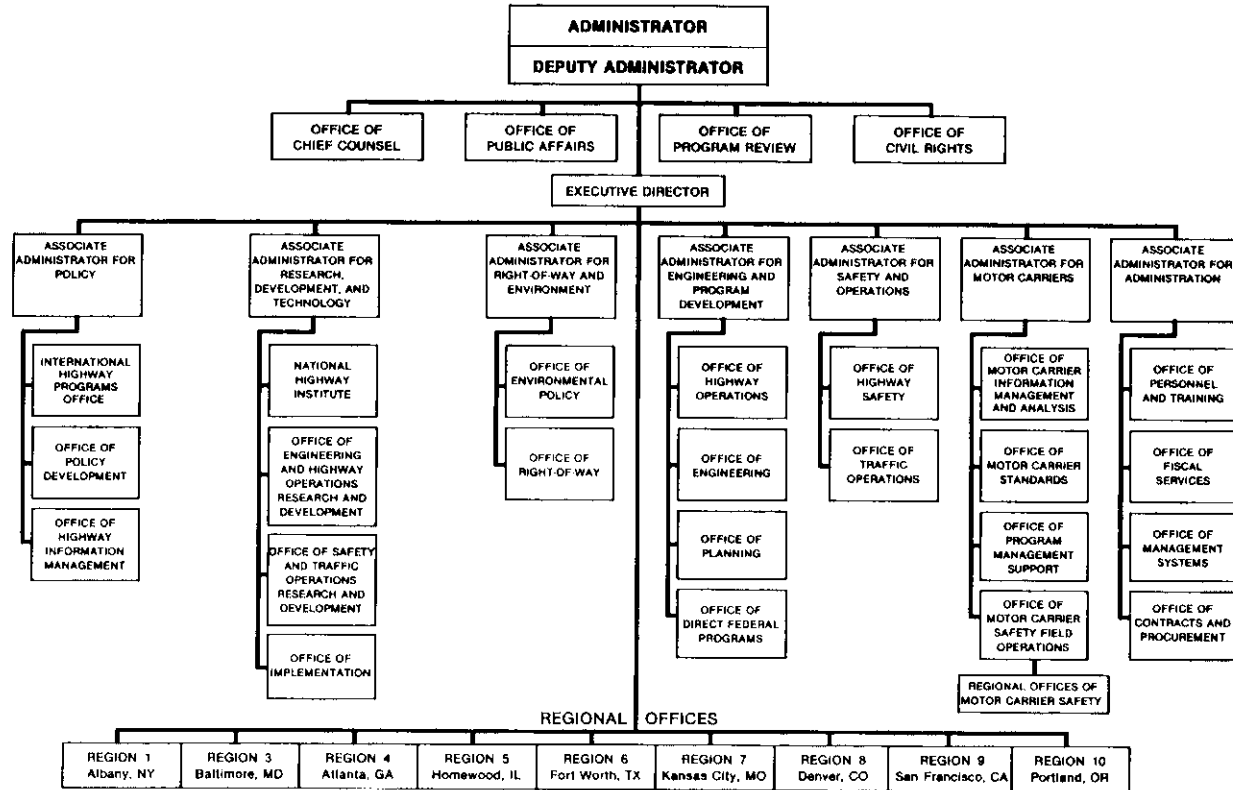


Fig. A.2—FHWA organization

Table A.2
HIGHWAY TRUST FUND RECEIPTS
(FY1984)

Source	Receipts (\$1000)	Percent
Motor fuel	\$10,405,049 ^a	80.9
Gasoline	(8,622,580)	(67.0)
Gasohol	(152,241)	(1.2)
Diesel and other	(1,630,228)	(12.7)
Trucks and trailers	864,823	6.7
Tires	319,748	2.5
Tubes	8,052	0.1
Tread rubber	3,802	0.0 ^b
Heavy truck use	179,665	1.4
Truck parts & accessories	-28,358 ^c	(0.2)
Lubricating oil	-10,156 ^c	(0.1)
Total	11,742,625	91.3
Interest earned	1,115,675 ^d	8.7
Total receipts	12,858,300	100.0

SOURCE: *Our Nation's Highways: Selected Facts and Figures*, 1985, p. 19.

^aIncludes transfers to mass transit account of \$1236 million

^bLess than 0.1 percent.

^cCredits.

^dIncludes \$89 million credited to mass transit account.

Table A.3
FEDERAL AID HIGHWAY PROGRAM
AUTHORIZATIONS

Program	Millions of Dollars
Interstate (initial construction)	4,000
Interstate 4R program ^a	2,400
Primary program	2,140
Secondary program	650
Urban program	800
Bridge replacement	1,650
Safety construction	390
Other	2,030
Total	14,060

SOURCE: *America on the Move*, 1984, p. 6.

^a4R: resurfacing, restoring, rehabilitating, and reconstructing.

Appendix B

REFERENCES ON FIBER-OPTICS COMMUNICATIONS

Textbooks

- Gagliardi, Robert M., and Sherman Karp, *Optical Communications*, John Wiley and Sons, New York, 1976.
- Jeunhomme, Lue, *Single-Mode Fiber Optics*, Marcel Dekker Inc., New York, 1983.
- Keiser, Gerd, *Optical Fiber Communications*, McGraw-Hill Inc., New York, 1983.
- Kao, C. K., *Optical Fiber Systems*, McGraw-Hill Inc., New York, 1982.
- Midwinter, J. E., *Optical Fibers for Transmission*, John Wiley and Sons, New York, 1979.
- Miller, S. E., and A. G. Chynoweth, *Optical Fiber Telecommunications*, Academic Press, New York, 1979.
- Okoshi, T., *Optical Fibers*, Academic Press, New York, 1982.
- Personick, S. D., *Optical Fiber Transmission Systems*, Plenum, New York, 1981.

Journal Articles

- Guterl, Fred, and Glenn Zorpette, "Fiber Optics: Poised to Displace Satellites," *IEEE Spectrum*, August 1985, p. 30.
- Henry, Paul S., "Introduction to Lightwave Transmission," *IEEE Communications Magazine*, May 1985, p. 12.
- Kapron, Felix P., "Fiber-Optic System Tradeoffs," *IEEE Spectrum*, March 1985, p. 68.
- , "The Evolution of Optical Fibers," *Microwave Journal*, April 1985, p. 111.
- Keck, Donald B., "Fundamentals of Optical Waveguide Fibers," *IEEE Communications Magazine*, May 1985, p. 17.
- Kogelnik, Herwig, "High-Speed Lightwave Transmission in Optical Fibers," *Science*, 31 May 1985, p. 1043.
- Kulm, Doug, "Fiber Optics for Telephony Applications," *Telephony*, five-part article: November 19, 1984, p. 84; December 3, 1984, p. 104; May 6, 1985, p. 109; May 20, 1985, p. 88; and October 21, 1985, p. 46.

- Lucky, Robert W., "Telecommunications Research and Development: A Look at the Next Twenty Years," *The Bridge*, Fall 1985, p. 2.
- Scerbo, L. J., et al. (eds.), "Engineering and Field Experience with Fiber Optic Systems," *IEEE Journal on Selected Areas in Communications*, August 1986.

Appendix C

MISCELLANEOUS SUPPORTING DOCUMENTATION

Item	Description
1	AASHTO Utility Accommodation Policy
2	23 CFR 645, Subpart B: Accommodation of Utilities
3	SASHTO Resolution
4	AASHTO Survey
5	New York Request
6	Survey of Governors
7	FHWA Notice of Review
8	NASHTO Resolution
9	Agenda for Initial Hearings in House
10	Approval of New York Thruway Exception
11	House Committee Report
12	Senate Committee Report
13	23 CFR 1.23: Rights-of-Way
14	23 U.S.C. 109: Standards
15	FHWA Notice of Proposed Rulemaking

Item 1

AASHTO Utility Accommodation Policy

INTRODUCTION

The Geometric Design Standards for the National System of Interstate and Defense Highways adopted by the American Association of State Highway Officials on July 12, 1956, and accepted by the Bureau of Public Roads on July 17, 1956, provide, in accordance with Section 109 of Title 23, U.S. Code, Highways, 1958, for control of access on all sections of the Interstate System. These provisions were established to provide for the maximum degree of safety and to preserve the traffic-carrying capacity, both of which are warranted by the large public fund investment in the facility. There are also other freeways with similar control of access features which are not part of the Interstate System.

Control of access can be materially affected by the extent and manner in which public utilities cross or otherwise occupy the highway right-of-way. The highway agencies have various degrees of authority to develop and maintain control of access and to regulate utilities, generally through their authority to designate and to control the use made of right-of-way acquired for public highways, including those of all freeways. Their authorities depend upon State laws or regulations. These laws and regulations differ in the several States and may be different in a State for highways utilizing existing right-of-way and for highways on new location for which right-of-way is to be acquired. A State may also have separate laws and regulations different from those applicable statewide, for highways on right-of-way subject to jurisdiction of a local government such as that of a large city.

In order to carry out the intent of Title 23, U.S. Code, a uniform policy is needed to establish the conditions under which public and private utilities may be accommodated on the freeway right-of-way. The following statements constitute such a policy. While the policy has as its primary purpose increasing and maintaining highway safety and function to the maximum and insuring uniformity of utility treatment among the States, it recognizes the public interest in avoiding unnecessary and costly operation of public utility organizations. The policy applies to all highways with full control of access, regardless of system. Also, it has value as a guide for all highways with partial control of access. The policy can be applied in most States by existing authority. Those States in which laws will not permit the application of this policy in its entirety should strive for uniformity through the enactment of appropriate legislation.

It is not the intent of this policy to impose restrictions on the future installations of utility crossings to the extent that would obstruct the development of expanding areas adjacent to the freeways.

This policy makes no reference to reimbursement to utility owners for the cost of adjusting or installing utilities on freeways. Reimbursement is subject to State laws.

It is the intent of this policy to establish procedures whereby the individual State highway authorities may uniformly administer the same.

STATEMENT OF POLICY

1. Utilities to Which Policy Applies

The principles set forth in this policy apply to all public and private utilities including but not limited to communication, electric power, water, gas, oil, petroleum products, steam, sewer, drainage, irrigation, and similar facilities. Such utilities may involve construction and maintenance of underground, surface or overhead facilities, either singly or in combination.

This policy shall apply to utilities located within public freeway right-of-way.

This policy does not apply to utility lines for servicing facilities required for operating the freeway.

2. New Utility Installations Along Freeways

New utilities will not be permitted to be installed longitudinally within the control of access lines of any freeway, except that in special cases such installations may be permitted under strictly controlled conditions. However, in each such case the utility owner must show that:

- A. The accommodation will not adversely affect the safety, design, construction, operation, maintenance or stability of the freeway;
- B. The accommodation will not be constructed and/or serviced by direct access from the thru traffic roadways or connecting ramps;
- C. The accommodation will not interfere with or impair the present use or future expansion of the freeway; and,
- D. Any alternative location would be contrary to the public interest. This determination would include an evaluation of the direct and indirect environmental and economic effects which would result from the disapproval of the use of such right-of-way for the accommodation of such utility.

3. Existing Utilities Along Proposed Freeways.

Where an utility already exists within the proposed right-of-way of a freeway and it can be serviced, maintained and operated without access from the through traffic roadways or ramps, it may remain as long as it does not adversely affect the safety, design, construction, operation, maintenance or stability of the freeway. Otherwise, it must be relocated.

4. Major Valley Crossings

Where a freeway crosses a major valley or river on an existing structure, any utility carried by said structure at the time the highway route is improved may continue to be so carried when relocation of the utility would be very costly and provided the utility can be serviced without interference with road users.

Expansion of a utility carried by an existing structure across a major valley or river may be permitted provided the utility can be installed and serviced without interference with road users.

A new utility will not be permitted to be installed on a structure across a major valley or river at and after the time the highway route is improved, except for special cases as covered by Item 2.

5. Utilities Crossing Freeways

New utility installations and adjustments or relocations of existing utilities may be permitted to cross a freeway. To the extent feasible and practicable they should cross on a line generally normal to the freeway alignment and preferably under the freeway.

5(A) Utilities Along Roads or Streets Crossing Freeways

Where a utility follows a crossroad or street which is carried over or under a freeway, provision should be made for the utility to cross the freeway on the locations of the crossroad or street in such manner that the utility can be serviced without access from the through-traffic roadways or ramps. Generally the utilities are to be located within the right-of-way of the crossroad or street, existing or relocated, and may cross over or under the freeway or be carried on or through the highway grade separation structure, provided installation and servicing thereof can be accomplished without access from the through-traffic roadways or ramps. Where distinct advantage and appreciable cost saving is effected by locating the utilities outside the right-of-way of the crossroad or street they may be so located, in which case they shall be located and treated in the same manner as utility lines crossing the freeway at points removed from grade separation structures as in (B) and (C) which follow.

5(B) Overhead Utility Crossings

Overhead utility lines crossing a freeway at points removed from grade separation structures, or those crossing near a grade separation but not within the right-of-way of a crossroad or street, in general, should be adjusted so that supporting structures are located outside the outer edges of through-traffic roadway side slopes and preferably outside the control access lines. In any case supporting poles shall not be placed within the appropriate clear zone as designated in the current edition of the AASHTO publication "Guide for Selecting, Locating and Designing Traffic Barriers." Supporting poles may be placed in medians of sufficient width to provide the above referenced clear zone from the edges of both roadways. If additional lanes are planned, the clear zone shall be determined from the ultimate edges of the roadway. Where right-of-way lines and control of access lines are not one and the same, as where frontage roads are provided, supporting poles may be located in the area between them. In extraordinary cases where such spanning of the roadways is not feasible, consideration may be given to conversion to underground facilities to cross the freeway.

At interchange areas, in general, support for overhead utilities should be permitted only where all of the following conditions are met: (a) the above indicated clear zone is provided with respect to the freeway through-traffic lanes, (b) the appropriate clear zone from edge of ramp is provided as designated in the above referenced AASHTO "Guide for Selecting, Locating and Designing Traffic Barriers," (c) essential sight distance is not impaired, and (d) the conditions of Item 7, "Access for Servicing Utilities," are satisfied.

The vertical clearance to overhead utility lines crossing freeways shall be determined by the State but in no case shall be less than the clearance required by the National Electrical Safety Code, ANSI C2, Institute of Electrical and Electronics Engineers, Inc.

5(C) Underground Utility Crossings

Utilities crossing underground below the freeways shall be of durable materials and so installed as to virtually preclude any necessity for disturbing the roadways to perform maintenance or expansion operations. The design and types of materials shall conform with appropriate governmental codes and specifications.

Manholes and other points of access to underground utilities may be permitted within the right-of-way of a freeway only when they are located beyond the shoulders of the through-traffic roadways or ramps as planned for later widening, if any, and only where they can be serviced or maintained without access from the through-traffic roadways or ramps.

5(D) Irrigation Ditches and Water Canals

Except for necessary crossings, water canals and irrigation ditches should be excluded from the right-of-way of freeways, except for special cases as covered by Item 2. Crossings may be made by underground siphon, or through culverts, or bridges as appropriate to the size of canal, topographic conditions, and highway safety aspects. In general, locations and structures are to be designed in the same manner as are facilities for natural transverse drainage.

All access and egress for servicing or patrolling such facilities shall be from outside the control of access lines. Ditch-walkers or ditch-riders shall not be permitted to indiscriminately cross the freeway at grade. Under appropriate traffic control arrangements, special ditch cleaning equipment may be permitted to cross in those cases where considerable extra travel distance would otherwise be required to utilize grade separation structures.

5(E) Provisions for Expansion of Utilities

When existing utilities are relocated or adjusted in conjunction with construction of a freeway, provision may be made for known and planned expansion of the utility facilities, particularly those underground. They should be planned to avoid interference with traffic at some future date when additional or new overhead or underground lines are installed.

6. Utilities in Vehicular Tunnels

As a general rule utilities will not be permitted to occupy vehicular tunnels on freeways on new location, except in special cases as covered by Item 2.

Utilities which transport a hazardous material shall not be allowed in a vehicular tunnel under any circumstances.

Where a utility occupies space in an existing vehicular tunnel that is converted to a freeway, relocation of the utility may not be required. Utilities which have not previously occupied an existing vehicular tunnel that is incorporated in a freeway will not be permitted therein, except in special cases as covered by Item 2.

7. Access for Servicing Utilities

Access for servicing a utility along or across a freeway should be limited to access via (a) frontage roads where provided, (b) nearby or adjacent public roads and streets, or (c) trails along or near the highway right-of-way lines, connecting only to an intersecting road, from any one or all of which entry may be made to the outer portion of the freeway right-of-way.

In those special cases, where utility supports, manholes, or other appurtenances are located in medians or interchange areas, access to them from through-traffic roadways or ramps may be permitted but only by permits issued by the highway agency to the utility owner setting forth the conditions for policing and other controls to protect highway users.

Where utilities are located outside the control of access line and where such utilities may require maintenance from within the freeway right-of-way, a permit must be obtained from the highway agency.

Advance arrangements should also be made between the utility and the highway agency for emergency maintenance procedures.

8. Construction and Location Details

The highway agency which constructs or maintains freeways has the right to review and approve the location and design of all utility installations and adjustments affecting the highway and issue permits for the contemplated work.

9. Manner of Making Utility Installations and Adjustments

In general, utility installations and adjustments are to be made with due consideration to highway and utility costs and in a manner that will provide maximum safety to the highway users, will cause the least possible interference with the highway facility and its operation, and will not increase the difficulty of or cost of maintenance of the highway.

SOURCE: Pages 2 through 7 of pamphlet, *A Policy on the Accommodation of Utilities Within Freeway Right-of-Way*, available through AASHTO, Suite 225, 444 North Capitol Street, N.W., Washington, D.C. 20001.

Item 2

23 CFR 645, Subpart B: Accommodation of Utilities

AUTHORITY: 23 U.S.C. 109, 116; 23 CFR 1.23 and 1.27; 49 CFR 1.48(b); E.O. 11990, 42 FR 26961 (May 24, 1977).

SOURCE: 50 FR 20354, May 15, 1985, unless otherwise noted.

§ 645.201 Purpose.

To prescribe policies and procedures for accommodating utility facilities and private lines on the right-of-way of Federal-aid or direct Federal highway projects.

§ 645.203 Applicability.

This subpart applies to:

(a) New utility installations within the right-of-way of Federal-aid or direct Federal highway projects,

(b) Existing utility facilities which are to be retained, relocated, or adjusted within the right-of-way of active projects under development or construction when Federal-aid or direct Federal highway funds are either being or have been used on the involved highway facility. When existing utility installations are to remain in place without adjustments on such projects the highway agency and utility are to enter into an appropriate

§ 645.205

agreement as discussed in § 645.213 of this part.

(c) Existing utility facilities which are to be adjusted or relocated under the provisions of § 645.209(k), and

(d) Private lines which may be permitted to cross the right-of-way of a Federal-aid or direct Federal highway project pursuant to State law and regulations and the provisions of this subpart. Longitudinal use of such right-of-way by private lines is to be handled under the provisions of 23 CFR 1.23(c).

§ 645.205 Policy.

(a) Pursuant to the provisions of 23 CFR 1.23, it is in the public interest for utility facilities to be accommodated on the right-of-way of a Federal-aid or direct Federal highway project when such use and occupancy of the highway right-of-way do not adversely affect highway or traffic safety, or otherwise impair the highway or its aesthetic quality, and do not conflict with the provisions of Federal, State or local laws or regulations.

(b) The manner in which utilities cross or otherwise occupy the right-of-way of a direct Federal or Federal-aid highway project can materially affect the highway, its safe operation, aesthetic quality, and maintenance. Therefore, it is necessary that such use and occupancy, where authorized, be regulated by highway agencies in a manner which preserves the operational safety and the functional and aesthetic quality of the highway facility. This subpart shall not be construed to alter the basic legal authority of utilities to install their facilities on public highways pursuant to law or franchise and reasonable regulation by highway agencies with respect to location and manner of installation.

(c) When utilities cross or otherwise occupy the right-of-way of a direct Federal or Federal-aid highway project on Federal lands, and when the right-of-way grant is for highway purposes only, the utility must also obtain and comply with the terms of a right-of-way or other occupancy permit for the Federal agency having jurisdiction over the underlying land.

23 CFR Ch. I (4-1-86 Edition)

§ 645.207 Definitions.

For the purpose of this regulation, the following definitions shall apply:

(a) *Aesthetic quality*—those desirable characteristics in the appearance of the highway and its environment, such as harmony between or blending of natural and manufactured objects in the environment, continuity of visual form without distracting interruptions, and simplicity of designs which are desirably functional in shape but without clutter.

(b) *Clear recovery area*—that portion of the roadside, within the highway right-of-way as established by the highway agency, free of nontraversable hazards and fixed objects. The purpose of such areas is to provide drivers of errant vehicles which leave the traveled portion of the roadway a reasonable opportunity to stop safely or otherwise regain control of the vehicle. The clear recovery area may vary with the type of highway, terrain traversed, and road geometric and operating conditions. The American Association of State Highway and Transportation Officials (AASHTO) "Guide for Selecting, Locating, and Designing Traffic Barriers," 1977, should be used as a guide for establishing clear recovery areas for various types of highways and operating conditions. (This publication is incorporated by reference and is on file at the Office of the Federal Register in Washington, D.C. It is available for inspection from the FHWA Washington Headquarters and all FHWA Division and Regional Offices as prescribed in 49 CFR Part 7, Appendix D. Copies of current AASHTO publications are available for purchase from the American Association of State Highway and Transportation Officials, Suite 225, 444 North Capitol Street, NW., Washington, D.C. 20001.)

(c) *Clear roadside policy*—that policy employed by a highway agency to provide a clear recovery area in order to increase safety, improve traffic operations, and enhance the aesthetic quality of highways by designing, constructing and maintaining highway roadsides as wide, flat, and rounded as practical and as free as practical from natural or manufac-

Federal Highway Administration, DOT

§ 645.209

tured hazards such as trees, drainage structures, nonyielding sign supports, highway lighting supports, and utility poles and other ground-mounted structures. The policy should address the removal of roadside obstacles which are likely to be associated with accident or injury to the highway user, or when such obstacles are essential, the policy should provide for appropriate countermeasures to reduce hazards. Countermeasures include placing utility facilities at locations which protect out-of-control vehicles, using breakaway features, using impact attenuation devices, or shielding. In all cases full consideration shall be given to sound engineering principles and economic factors.

(d) *Direct Federal highway projects*—those active or completed highway projects such as projects under the Federal Lands Highways Program which are under the direct administration of the Federal Highway Administration (FHWA)

(e) *Federal-aid highway projects*—those active or completed highway projects administered by or through a State highway agency which involve or have involved the use of Federal-aid highway fund, for the development, acquisition of right-of-way, construction or improvement of the highway or related facilities, including highway beautification projects under 23 U.S.C. 319, Landscaping and Scenic Enhancement.

(f) *Freeway*—a divided arterial highway with full control of access.

(g) *Highway agency*—that department, agency, commission, board, or official of any State or political subdivision thereof, charged by its law with the responsibility for highway administration.

(h) *Highway*—any public way for vehicular travel, including the entire area within the right-of-way and related facilities constructed or improved in whole or in part with Federal-aid or direct Federal highway funds.

(i) *Private lines*—privately owned facilities which convey or transmit the commodities outlined in paragraph (m) of this section, but devoted exclusively to private use.

(j) *Right-of-way*—real property, or interests therein, acquired, dedicated

or reserved for the construction, operation, and maintenance of a highway in which Federal-aid or direct Federal highway funds are or have been involved in any stage of development. Lands acquired under 23 U.S.C. 319 shall be considered to be highway right-of-way.

(k) *State highway agency*—the highway agency of one of the 50 States, the District of Columbia, or Puerto Rico.

(l) *Use and occupancy agreement*—the document (written agreement or permit) by which the highway agency approves the use and occupancy of highway right-of-way by utility facilities or private lines.

(m) *Utility facility*—privately, publicly or cooperatively owned line, facility, or system for producing, transmitting, or distributing communications, cable television, power, electricity, light, heat, gas, oil, crude products, water, steam, waste, storm water not connected with highway drainage, or any other similar commodity, including any fire or police signal system or street lighting system, which directly or indirectly serves the public. The term utility shall also mean the utility company inclusive of any wholly owned or controlled subsidiary.

§ 645.209 General requirements.

(a) *Safety*. Highway safety and traffic safety are of paramount, but not of sole, importance when accommodating utility facilities within highway right-of-way. Utilities provide an essential public service to the general public. Traditionally, as a matter of sound economic public policy and law, utilities have used public road right-of-way for transmitting and distributing their services. However, due to the nature and volume of highway traffic, the effect of such joint use on the traveling public must be carefully considered by highway agencies before approval of utility use of the right-of-way of Federal-aid or direct Federal highway projects is given. Adjustments in the operating characteristics of the utility or the highway or other special efforts may be necessary to increase the compatibility of utility-highway joint use. The possibility of

§ 645.209

23 CFR Ch. I (4-1-86 Edition)

this joint use should be a consideration in establishing right-of-way requirements for highway projects. In any event, the design, location, and manner in which utilities use and occupy the right-of-way of Federal-aid or direct Federal highway projects must conform to the clear roadside policies for the highway involved and otherwise provide for a safe traveling environment as required by 23 U.S.C. 109 (1)(1).

(b) *New above ground installations.* On Federal-aid or direct Federal highway projects, new above ground utility installations, where permitted, shall be located as far from the traveled way as possible, preferably along the right-of-way line. No new above ground utility installations are to be allowed within the established clear recovery of the highway unless a determination has been made by the highway agency that placement underground is not technically feasible or is unreasonably costly and there are no feasible alternate locations. In exceptional situations when it is essential to locate such above ground utility facilities within the established clear recovery area of the highway, appropriate countermeasures to reduce hazards shall be used. Countermeasures include placing utility facilities at locations which protect or minimize exposure to out-of-control vehicles, using breakaway features, using impact attenuation devices, using delineation, or shielding.

(c) *Installations within freeways.* Since the preservation of the control of access feature of freeways is essential to the safe and efficient use of such highways, longitudinal utility use of freeway right-of-way within the access control lines will not be permitted unless such use is clearly justified due to special and unique circumstances and when denial of such use would result in undue or exceptional hardship on utility consumers or others. Utility installations on freeway right-of-way shall conform to the provisions of the AASHTO publication, "A Policy on the Accommodation of Utilities Within Freeway Right-of-Way," 1982, except as modified herein. (This publication is incorporated by reference and is on file at the Office of

the Federal Register in Washington, D.C. It is available for inspection from the FHWA Washington Headquarters and all FHWA Division and Regional Offices as prescribed in 49 CFR Part 7, Appendix D. Copies of current AASHTO publications are available for purchase from the American Association of State Highway and Transportation Officials, Suite 225, 444 North Capitol Street, NW., Washington, D.C. 20001.) New utilities will not be permitted to be installed longitudinally within the access control lines of a Federal-aid freeway except (1) for those instances warranted under the provisions of 23 U.S.C. 109 (1)(1) (B) and (C) to mitigate damage to agricultural lands, provided (a) there is adequate right-of-way available which is not needed for planned highway expansion, and (b) such use does not adversely affect highway safety, highway operations or otherwise impair the highway, its aesthetic quality, or its maintenance, and (c) it can be shown that the installation on the freeway right-of-way is the most feasible and prudent location available; or (2) for those special cases warranted under Item 2, New Utility Installations Along Freeways, of the aforementioned AASHTO policy. However, in applying the criteria of Item 2 of the AASHTO policy, the FHWA may allow utility facilities to be located within interchange areas and may allow construction and/or servicing of such facilities from the through roadways or ramps provided conditions A, C, and D of Item 2 are satisfied and provided such access is by permits issued by the highway agency to the utility owner setting forth the conditions for policing and other controls to protect highway users. When longitudinal installations are proposed within existing access control lines, a utility strip shall be established by locating a utility access control line between the proposed utility facility and the through roadway and ramps. Existing fences should be retained and, except along sections of freeways having frontage roads, planned fences should be located at the freeway right-of-way line. Nothing in this part shall be construed as prohibiting a highway agency from adopting a more restric-

tive policy than that contained herein with regard to longitudinal utility installations along freeway right-of-way and access for constructing and/or servicing such installations.

(d) *Uniform policies and procedures.* For a highway agency to fulfill its responsibilities to control utility use of Federal-aid highway right-of-way within the State and its political subdivisions, it must exercise or cause to be exercised, adequate regulation over such use and occupancy through the establishment and enforcement of reasonably uniform policies and procedures for utility accommodation.

(e) *Private lines.* Because there are circumstances when private lines may be allowed to cross or otherwise occupy the right-of-way of Federal-aid projects, highway agencies shall establish uniform policies for properly controlling such permitted use. When permitted, private lines must conform to the provisions of this part and the provisions of 23 CFR 1.23(c) for longitudinal installations.

(f) *Direct Federal highway projects.* On direct Federal highway projects, the FHWA will apply, or cause to be applied, utility and private line accommodation policies similar to those required on Federal-aid highway projects. When appropriate, agreements will be entered into between the FHWA and the highway agency or other government agencies to ensure adequate control and regulation of use by utilities and private lines of the right-of-way on direct Federal highway projects.

(g) *Projects where state lacks authority.* On Federal-aid highway projects where the State highway agency does not have legal authority to regulate highway use by utilities and private lines, the State highway agency must enter into formal agreements with those local officials who have such authority. The agreements must provide for a degree of protection to the highway at least equal to the protection provided by the State highway agency's utility accommodation policy approved under the provisions of § 645.215(b) of this part. The project agreement between the State highway agency and the FHWA on all such Federal-aid highway projects shall

contain a special provision incorporating the formal agreements with the responsible local officials.

(h) *Scenic areas.* New utility installations, including those needed for highway purposes, such as for highway lighting or to serve a weigh station, rest area or recreation area, are not permitted on highway right-of-way or other lands which are acquired or improved with Federal-aid or direct Federal highway funds and are located within or adjacent to areas of scenic enhancement and natural beauty. Such areas include public park and recreational lands, wildlife and waterfowl refuges, historic sites as described in 23 U.S.C. 138, scenic strips, overlooks, rest areas and landscaped areas. The State highway agency may permit exceptions provided the following conditions are met:

(1) New underground or aerial installations may be permitted only when they do not require extensive removal or alteration of trees or terrain features visible to the highway user or impair the aesthetic quality of the lands being traversed.

(2) Aerial installations may be permitted only when:

(i) Other locations are not available or are unusually difficult and costly, or are less desirable from the standpoint of aesthetic quality,

(ii) placement underground is not technically feasible or is unreasonably costly, and

(iii) the proposed installation will be made at a location, and will employ suitable designs and materials, which give the greatest weight to the aesthetic qualities of the area being traversed. Suitable designs include, but are not limited to, self-supporting armless, single-pole construction with vertical configuration of conductors and cable.

(3) For new utility installations within freeways, the provisions of paragraph (c) of this section must also be satisfied.

(i) *Joint use agreements.* When the utility has a compensable interest in the land occupied by its facilities and such land is to be jointly occupied and used for highway and utility purposes, the highway agency and utility shall agree in writing as to the obligations

§ 645.211

23 CFR Ch. I (4-1-86 Edition)

and responsibilities of each party. Such joint-use agreements shall incorporate the conditions of occupancy for each party, including the rights vested in the highway agency and the rights and privileges retained by the utility. In any event, the interest to be acquired by or vested in the highway agency in any portion of the right-of-way of a Federal-aid or direct Federal highway project to be vacated, used or occupied by utilities or private lines, shall be adequate for the construction, safe operation, and maintenance of the highway project.

(j) *Traffic control plan.* Whenever a utility installation, adjustment or maintenance activity will affect the movement of traffic or traffic safety, the utility shall implement a traffic control plan and utilize traffic control devices as necessary to ensure the safe and expeditious movement of traffic around the work site and the safety of the utility work force in accordance with procedures established by the highway agency. The traffic control plan and the application of traffic control devices shall conform to the standards set forth in the "Manual on Uniform Traffic Control Devices" (MUTCD) and 23 CFR Part 630, Subpart J. (This publication is incorporated by reference and is on file at the Office of the Federal Register in Washington, D.C. It is available for inspection and copying from the FHWA Washington Headquarters and all FHWA Division and Regional Offices as prescribed in 49 CFR Part 7, Appendix D.)

(k) *Corrective measures.* When the highway agency determines that existing utility facilities are likely to be associated with injury or accident to the highway user, as indicated by accident history or safety studies, the highway agency shall initiate or cause to be initiated in consultation with the affected utilities, corrective measures to provide for a safer traffic environment. The corrective measures may include changes to utility or highway facilities and should be prioritized to maximum safety benefits in the most cost-effective manner. The scheduling of utility safety improvements should take into consideration planned utility replacement or upgrading schedules, accident

potential, and the availability of resources. It is expected that the requirements of this paragraph will result in an orderly and positive process to address the identified utility hazard problems in a timely and reasonable manner with due regard to the effect of the corrective measures on both the utility consumer and the road user. The type of corrective measures are not prescribed. Any requests received involving Federal participation in the cost of adjusting or relocating utility facilities pursuant to this paragraph shall be subject to the provisions of 23 CFR Part 645, Subpart A, Utility Relocations, Adjustments and Reimbursement, and 23 CFR Part 924, Highway Safety Improvement Program.

(l) *Wetlands.* The installation of privately owned lines or conduits on the right-of-way of Federal-aid or direct Federal highway projects for the purpose of draining adjacent wetlands onto the highway right-of-way is considered to be inconsistent with Executive Order 11990, Protection of Wetlands, dated May 24, 1977, and shall be prohibited.

§ 645.211 State highway agency accommodation policies.

The FHWA shall use the AASHTO publications, "A Guide for Accommodating Utilities Within Highway Right-of-Way," 1981, and "Guide for Selecting, Locating and Designing Traffic Barriers," 1977, to assist in the evaluation of adequacy of State highway agency utility accommodation policies. (These publications are incorporated by reference and are on file at the Office of the Federal Register in Washington, D.C. They are available for inspection from the FHWA Washington Headquarters and all FHWA Division and Regional Offices as prescribed in 49 CFR Part 7, Appendix D. Copies of current AASHTO publications are available for purchase from the American Association of State Highway and Transportation Officials, Suite 225, 444 North Capitol Street, NW., Washington, D.C. 20001). As a minimum, such policies shall make adequate provisions with respect to the following:

Federal Highway Administration, DOT

§ 645.213

(a) Utilities must be accommodated and maintained in a manner which will not impair the highway or adversely affect highway or traffic safety.

(b) Consideration shall be given to the effect of utility installations in regard to safety, aesthetic quality, and the costs or difficulty of highway and utility construction and maintenance.

(c) The State highway agency's standards for regulating the use and occupancy of highway right-of-way by utilities must include, but are not limited to, the following:

(1) The horizontal and vertical location requirements and clearances for the various types of utilities must be clearly stated. These must be adequate to ensure compliance with the clear roadside policies for the particular highway involved.

(2) The applicable provisions of government or industry codes required by law or regulation must be set forth or appropriately referenced, including highway design standards or other measures which the State highway agency deems necessary to provide adequate protection to the highway, its safe operation, aesthetic quality, and maintenance.

(3) Specifications for and methods of installation; requirements for preservation and restoration of highway facilities, appurtenances, and natural features and vegetation on the right-of-way; and limitations on the utility's activities within the right-of-way including installation within areas set forth by § 645.209(h) of this part should be prescribed as necessary to protect highway interests.

(4) Measures necessary to protect traffic and its safe operation during and after installation of facilities, including control-of-access restrictions, provisions for rerouting or detouring traffic, traffic control measures to be employed, procedures for utility traffic control plans, limitations on vehicle parking and materials storage, protection of open excavations, and the like must be provided.

(5) A State highway agency may deny a utility's request to occupy highway right-of-way based on State law, regulation, or ordinances or the State highway agency's policy. However,

in any case where the provisions of this part are to be cited as the basis for disapproving a utility's request to use and occupy highway right-of-way, measures must be provided to evaluate the direct and indirect environmental and economic effects of any loss of productive agricultural land or any impairment of the productivity of any agricultural land that would result from the disapproval. The environmental and economic effects on productive agricultural land together with the possible interference with or impairment of the use of the highway and the effect on highway safety must be considered in the decision to disapprove any proposal by a utility to use such highway right-of-way.

(d) Compliance with applicable State laws and approved State highway agency utility accommodation policies must be assured. The responsible State highway agency's file must contain evidence of the written arrangements which set forth the terms under which utility facilities are to cross or otherwise occupy highway right-of-way. All utility installations made on highway right-of-way shall be subject to written approval by the State highway agency. However, such approval will not be required where so provided in the use and occupancy agreement for such matters as utility facility maintenance, installation of service connections on highways other than freeways, or emergency operations.

(The information collection requirements in paragraphs (a), (b) and (c) of this section have been approved under OMB control number 2125-0522; the information collection requirements in paragraph (d) of this section have been approved under OMB control number 2125-0514.)

§ 645.213 Use and occupancy agreements (permits).

The written arrangements, generally in the form of use and occupancy agreements setting forth the terms under which the utility is to cross or otherwise occupy the highway right-of-way, must include or incorporate by reference:

(a) The highway agency standards for accommodating utilities. Since all of the standards will not be applicable to each individual utility installation,

§ 645.215

23 CFR Ch. I (4-1-86 Edition)

the use and occupancy agreement must, as a minimum, describe the requirements for location, construction, protection of traffic, maintenance, access restriction, and any special conditions applicable to each installation.

(b) A general description of the size, type, nature, and extent of the utility facilities being located within the highway right-of-way.

(c) Adequate drawings or sketches showing the existing and/or proposed location of the utility facilities within the highway right-of-way with respect to the existing and/or planned highway improvements, the traveled way, the right-of-way lines and, where applicable, the control of access lines and approved access points.

(d) The extent of liability and responsibilities associated with future adjustment of the utilities to accommodate highway improvements.

(e) The action to be taken in case of noncompliance with the highway agency's requirements.

(f) Other provisions as deemed necessary to comply with laws and regulations.

(The information collection requirements in this section have been approved under OMB control number 2125-0522)

§ 645.215 Approvals.

(a) Each State highway agency shall submit a statement to the FHWA on the authority of utilities to use and occupy the right-of-way of State highways, the State highway agency's power to regulate such use, and the policies the State highway agency employs or proposes to employ for accommodating utilities within the right-of-way Federal-aid highways under its jurisdiction. Statements previously submitted and approved by the FHWA need not be resubmitted provided the statement adequately addresses the requirements of this part. When revisions are deemed necessary the changes to the previously approved statement may be submitted separately to the FHWA for approval. The State highway agency shall include similar information on the use and occupancy of such highways by private lines where permitted. The State shall identify those areas, if any, of the Federal-aid highway system within its

borders where the State highway agency is without legal authority to regulate use by utilities. The statement shall address the nature of the formal agreements with local officials required by § 645.209(g) of this part. It is expected that the statements required by this part or necessary revisions to previously submitted and approved statements will be submitted to FHWA within 1 year of the effective date of this regulation.

(b) Upon determination by the FHWA that a State highway agency's policies satisfy the provisions of 23 U.S.C. 109 and 116, and 23 CFR 1.23 and 1.27, and meet the requirements of this regulation, the FHWA may approve their use on Federal-aid highway projects in that State.

(c) Any changes, additions or deletions the State highway agency proposes to the approved policies are subject to FHWA approval.

(d) When a utility files a notice or makes an individual application or request to a State highway agency to use or occupy the right-of-way of a Federal-aid highway project, the State highway agency is not required to submit the matter to the FHWA for prior concurrence, except under the following circumstances:

(1) The proposed installation is not in accordance with this regulation or the State highway agency's utility accommodation policy approved by the FHWA for use on Federal-aid highway projects.

(2) Longitudinal installations on Federal-aid freeways involving special case exceptions, as described in the AASHTO publication, "A Policy on the Accommodation of Utilities Within Freeway Right-of-Way," 1982, and § 645.209(c) of this part.

(3) Longitudinal installations of private lines.

(e) The State highway agency's practices under the policies or agreements approved under § 645.215(b) of this part shall be periodically reviewed by the FHWA.

(The information collection requirements in paragraph (a) of this section have been approved under OMB control number 2125-0514)

Item 3

SASHTO Resolution

CONTROL OF ACCESS ON INTERSTATE HIGHWAYS AND FREEWAYS

WHEREAS, certain owners and users of fiber optics technology have for several years now been working to bring about changes in the policies of State and Federal Transportation Organizations to permit the free use of rights-of-way heretofore acquired for the National System of Interstate & Defense Highways and other freeways, for the purpose of installing fiber optic cables and other optical communication systems; and

WHEREAS, such use of fully-controlled access highway rights-of-way by one type of utility to the exclusion of all others cannot in fairness be justified; and

WHEREAS, such use of said rights-of-way would also in many instances necessitate the owners and operators of such utilities having access from the through traffic roadways and ramps of interstate highways and other freeways, thereby unnecessarily endangering the traveling public and defeating the original purposes of access control.

NOW THEREFORE BE IT RESOLVED THAT SASHTO strongly supports the existing "Policy on the Accommodation of Utilities Within Freeway Right-of-Way" as currently approved and adopted by the American Association of State Highway Officials and incorporated by reference in Federal Highway Administration Policy & Procedure Memorandum 30-4.1

BE IT FURTHER RESOLVED THAT SASHTO opposes any relaxation in the administration of current access control policies by the Federal Highway Administration or by the State Highway Transportation Organizations.

BE IT FURTHER RESOLVED THAT this resolution be submitted to the Chairmen of the House Public Works and Transportation Committee and the Senate Environment and Public Works Committee.

BE IT FURTHER RESOLVED THAT a copy of this resolution be submitted to the Policy Committee of AASHTO, to the Federal Highway Administrator and to the Head of the State Transportation Organization in each of the fifty States.

Adopted by SASHTO Board of Directors on September 15, 1985.

Item 4

AASHTO Survey



Department of Transportation

HIGHWAY DIVISION

TRANSPORTATION BUILDING, SALEM, OREGON 97310

ROAD DESIGN SECTION

November 7, 1985

In Reply Refer to
File No. -
ORG

TO: AASHTO Policy Committee
Richard P. Braun, Chairman
Francis B. Francois, Secretary

FROM: Duane O. Christensen, Chairman
Fiber Optics Task Force

SUBJECT: Longitudinal Occupancy of Freeways by Utilities

The AASHTO Fiber Optics Task Force was organized by Leo J. Trombatore, Chairman of the Standing Committee on Highways, in September 1985 and charged with the responsibility to:

- 1) explore the need for a change in the AASHTO "Policy on the Accommodation of Utilities within Freeway Right-of-Way."
- 2) develop recommendations for a potential change to the present AASHTO Policy.

EXISTING POLICIES

Regulations governing utilities on Federal-aid freeway rights-of-way are contained in Federal Highway Administration Program Manual 6-6-3-2, "Accommodation of Utilities", issued September 6, 1985. This document, in turn, requires that all utility installations on freeway right-of-way shall conform to the provisions of the publication, "A Policy on the Accommodation of Utilities within Freeway Right-of-Way", published by the American Association of State Highway and Transportation Officials (AASHTO) in 1982.

FHPM 6-6-3-2 states that, "Since the preservation of the control of the access feature of freeways is essential to the safe and efficient use of such highways, the longitudinal use of freeway right-of-way within the access control lines will not be permitted unless such use is clearly justified due to special and unique circumstances and when denial of such use would result in undue or exceptional hardship on utility consumers or others."

"Prior concurrence from FHWA is required for longitudinal installation of utilities on Federal-aid freeways."

AASHTO Policy Committee
 November 7, 1985
 Page two

Among the provisions included within the AASHTO policy are the following: "New utilities will not be permitted to be installed longitudinally within the control-of-access lines of any freeway, except that in special cases such installations may be permitted under strictly controlled conditions. However, in each case the utility owner must show that:

- A. The accommodation will not adversely affect the safety, design, construction, operation, maintenance or stability of the freeway;
- B. The accommodation will not be constructed and/or serviced by direct access from the thru traffic roadways or connecting ramps;
- C. The accommodation will not interfere with or impair the present use or future expansion of the freeway; and,
- D. Any alternative location would be contrary to public interest. This determination would include an evaluation of the direct and indirect environmental and economic effects which would result from the disapproval of the use of such right of way for the accommodation of such utility."

"Where an utility already exists within the proposed right-of-way of a freeway and it can be serviced, maintained and operated without access from the through traffic roadways or ramps, it may remain as long as it does not adversely affect the safety, design, construction, operation, maintenance or stability of the freeway. Otherwise it must be relocated."

From the present policies of the Federal Highway Administration and the American Association of State Highway Officials the intent is clear: longitudinal utility installations should not be permitted within the control-of-access limits of freeways except for special cases where such installations may be permitted under strictly controlled conditions.

The FHWA utility accommodation policy has provided the vehicle by which two types of longitudinal utility installations can occur:

- 1) Short runs in new freeways in cases where extreme hardship is demonstrated.
- 2) Those special cases warranted under item 2, New Utility Installations Along Freeways, as defined in the AASHTO policy. These installations being within a utility strip located along the outer border of the existing freeway right of way.

Utility companies and public utility agencies seeking to install facilities within freeway rights-of-way have found varying interpretations of the utility accommodation policies by states. Some

AASHTO Policy Committee
November 7, 1985
Page three

states recognize the need of flexibility allowing utilities to occupy freeway rights-of-way for short distances when other alternatives are unfeasible. Many state laws prohibit utilities from freeway rights-of-way altogether.

As a general rule, the Federal Highway Administration has been opposed to utilities being placed longitudinally on freeway rights-of-way.

NEED FOR REVIEWING CURRENT AASHTO POLICY

As time goes on and conditions change, there is always a need to step back and take a look at past policies. The time has come to review the policy on the location of utilities within freeway rights-of-way.

The public may benefit from joint occupancy by utilities: undisturbed land is preserved; freeways may provide the most direct route for intercity-interstate transmission; the protected environment between freeway access offers security to utility lifelines from third party damage; and, because of favorable grade and alignment, freeways may provide the most economical corridors for utilities to construct transmission lines. The savings realized by utilities on joint use of freeway rights-of-way benefit utility customers who are, in most cases, the same general public using the freeway.

Underground communication cables appear to be the most compatible for freeways and require the least right-of-way width. Sanitary and storm sewers and water lines generally require wider rights-of-way, and above-ground support facilities are generally spaced more closely than communication repeater stations. Support structures for aerial communication cables can become safety hazards to freeway motorists if not properly protected. Petroleum and natural gas pipelines, while located underground, have inherent fire and explosion potentials.

Aerial power transmission cables, being potentially dangerous and located continuously above-ground, appear to be the least compatible for freeway operations.

Many states have recently been approached by the fiber-optics communication field to utilize interstate freeway rights-of-way for their installations. This requires a consistent and uniform answer.

An even more pressing need to review the AASHTO policy has been presented recently. The National Communication System has engaged the Rand Corporation to assess the feasibility of using the Interstate highway system, along with other federal, state, and local tributaries, as rights-of-way for construction of more survivable, long-line, communication systems. This study may well point out a need to use Interstate

AASHTO Policy Committee
November 7, 1985
Page four

rights-of-way for fiber-optics telecommunications for national security. Because of these conditions, AASHTO is in the process of developing a position on the need for a change in present policy, and, if the need is deemed necessary, will determine under what conditions, if any, utilities should be allowed on the Interstate rights-of-way. To help formulate this AASHTO position, the Fiber Optics Task Force has put together questions to assist in determining the merits, benefits and/or reasons why utilities should or should not be allowed on Interstate freeway rights-of-way.

The Task Force has been charged to come up with findings and recommendations by mid-December, 1985 so that the Standing Committee on Highways and the AASHTO Policy Committee can act. They will provide feedback to the National Communications System and Department of Transportation, who are responsible for the Rand Study.

Please have your appropriate staff complete the enclosed questionnaire as soon as possible. I will need it in my office by Friday, November 29, 1985.

Send to: Duane O. Christensen
Road Design Engineer
Department of Transportation
200 Transportation Building
Salem, Oregon 97310

DOC:bn

cc: Leo Trambatore
Task Force Members

FIBER OPTICS TASK FORCE QUESTIONNAIRE

November 1985

1. Please outline the position of your Department in regard to the multiple use of Interstate highway rights-of-way by public utilities.
2. Would your Department's position be different if use was limited to
 - (a) underground communications facilities? _____
Why?
 - (b) underground fiber optics system? _____
Why?
3. Would your Department support use of Interstate ROW for a National Defense communications system?
4. In your opinion, can an accommodation policy be developed to permit fiber optic cable to occupy Interstate and freeway rights-of-way while restricting other buried utilities? For example, could criteria such as complexity of installation and maintenance, frequency of repairs, or potential damage from a "break" (i.e., water washing away some portion of the roadbed if a water main broke) be used to define utilities to be accommodated?

5. Do public utilities in your state have to obtain permission of adjacent property owners when installing their facilities on highway rights-of-way dedicated to the government agency for highway purposes only?
6. Regardless of your position in relation to use by public utilities, should the appropriate agency of your state be allowed to place underground communication facilities on Interstate ROW to accommodate state government business and operation needs?
7. Should the state be permitted to lease a portion of these facilities for non-government use?
8. To what extent would the motoring public's safety and convenience be degraded if joint use of Interstate rights-of-way were permitted for:
 - (a) all public utilities?
 - (b) all public utilities placed underground?
 - (c) communication utilities placed underground?
 - (d) If fiber optic cable construction plans placed repeaters and terminal equipment off the Interstate and freeway rights-of-way, the points of most frequent maintenance would not need to be accessed from the Interstate or freeway roadway. Also, once buried, spliced, and tested, the fiber optic cable, itself, requires very little maintenance. Under these circumstances to what extent do you perceive the safety of Interstate and freeway motorists are at risk if state prescribed safety policies are followed?

9. What other negative impacts can be expected from placing communication cables on the Interstate?
10. Should utilities be allowed underground in the median of divided highways?
11. Should the number of communication lines permitted be restricted and granted to the successful bidder?
12. Would you be required to pass enabling legislation in order to implement an AASHTO/FHWA policy change to accommodate communication cable on Interstate or freeway rights-of-way? If such legislation is required, are any problems anticipated?
13. Should the AASHTO "Policy on the Accommodation of Utilities within Freeway Right-of-Way" be modified to permit longitudinal installations of utilities on Interstate ROW? _____
If so, all, or which ones?
14. If so, should buildings or other facilities to pump or amplify transmission be permitted on the ROW?

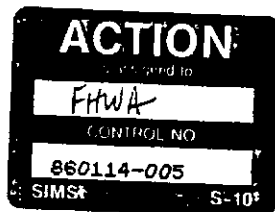
Item 5

New York Request



STATE OF NEW YORK
EXECUTIVE CHAMBER
ALBANY 12224

MARIO M. CUOMO
GOVERNOR



January 10, 1986

Dear Secretary Dole:

I am forwarding for your review the New York State Thruway Authority's application for a waiver of the Federal Highway Administration (FHWA) regulations which restrict the installation of fiber optic cables along the Thruway's right-of-way.

The Thruway Authority has been advised that it is required to comply with these regulations as a result of the Section 105 agreement. While the language in this agreement appears to apply only to limited portions of the Thruway which have been improved with Federal aid, we recognize that a waiver of the FHWA regulations might be required if portions of the Thruway which have received Federal aid are included in the Thruway Authority's plan.

Installing a fiber optic cable along the entire Thruway would dramatically improve the State's communications infrastructure, create cost savings for consumers, and attract high-tech industry and jobs to New York, all at no cost to taxpayers.

At the same time, the fiber optic cable would pose no threat to the accessibility and safety of the Thruway nor would it diminish its primary transportation purpose. Unlike traditional utility installations, fiber optic cable can be easily and safely installed underground at the edge of the Thruway right-of-way and is virtually maintenance-free.

I respectfully urge your review of the Department's policy on this issue and favorable action on the Thruway Authority's request.

With best wishes for the New Year.

Sincerely,

A handwritten signature in dark ink, reading "Mario M. Cuomo".

Honorable Elizabeth H. Dole
Secretary of Transportation
400 Seventh Street, S.W.
Washington, DC 20590



HENRY A. BERSANI
CHAIRMAN

LOUISE M. SUNSHINE
VICE CHAIRMAN

CHARLES T. LANIGAN
TREASURER

NEW YORK STATE THRUWAY AUTHORITY
200 SOUTHERN BOULEVARD
ALBANY, NEW YORK 12209

MAILING ADDRESS P O BOX 169, ALBANY, N. Y. 12201
PHONE: AREA CODE (518) 469-1750

ALEXANDER A. LEVINE
EXECUTIVE DIRECTOR

January 9, 1986

Mr. R. A. Barnhart
Federal Highway Administrator
U. S. Department of Transportation
Federal Highway Administration
Washington, D. C. 20590

Dear Mr. Barnhart:

The New York State Thruway Authority has recently received proposals for the longitudinal installation of underground fiber optic cable along its right-of-way. In connection with that request, on May 20, 1985 we contacted Mr. Victor E. Taylor, FHWA Division Administrator for New York State to inquire about the application of Federal regulations and policies involving longitudinal occupancies for utilities on the Thruway. Mr. Taylor advised us on July 5, 1985 that as a result of the execution of the Agreement in 1982 between the Authority, NYS Department of Transportation and FHWA regarding the acceptance and use of Federal funds under Section 105 of the Surface Transportation Act of 1978, the Authority is obligated to abide by the requirements of the FHWA policies which preclude using Thruway's right-of-way for longitudinal fiber optic communication facilities except under specified conditions.

This decision was rendered inspite of the fact that practically all of the right-of-way was acquired without Federal funds and that subsequent to the execution of the Section 105 Agreement only limited portions of the Thruway have benefitted from Federal aid for specific rehabilitation or reconstruction projects. While it is clear that Federal funds have not been used on projects affecting the entire length of the Thruway nor was the Thruway right-of-way acquired with Federal

Mr. R. A. Barnhart

2

January 9, 1980

funds, it was unclear whether or not both these factors were fully taken into consideration in arriving at the earlier opinion that was communicated to us by Mr. Taylor.

In the interest of clarity, we are requesting your reconsideration of that opinion in view of these circumstances. Also, for the additional reasons stated hereafter, we request a waiver of the prohibition against the longitudinal installation of utilities in order to permit the installation of underground fiber optic communications facilities along the right-of-way of the Thruway.

We particularly request your concurrence in the Thruway's proposed permit to allow the New York Telephone Company to install lightwave cable from milepost 149.55 to milepost 155.54, for a total length of 5.99 miles in Albany and Schenectady counties. Attachment A describes where the lightwave cable will be located along the right-of-way. It also details the reasoning and engineering judgement used to conclude that the longitudinal occupancy of Thruway property would result in the most economical and practical means of providing the required service which New York Telephone considers essential to their operations in the short term future. Attachment A also includes alternative routing and its impact.

The New York Telephone Company's application for a longitudinal occupancy permit has served to illuminate the larger concerns about this State's need to foster and support the emerging fiber optic communications systems, either directly or through its agencies, such as the Thruway. Consequently, we, the Thruway, now believe that a general waiver is appropriate and make that request based on the following factors:

1. Benefits to Consumers

If use of the Thruway right-of-way is not allowed, the consumers and residents of New York will be adversely affected.

As illustrated in Attachment A, if New York Telephone is forced to install fiber optics along State Route 5, the cost will be \$1.5 million more than if the Thruway right-of-way was used, which in turn will be passed on to consumers. In addition, private residents, commercial businesses, and the motoring public will be significantly disrupted during the Route 5 construction. There is also a clear possibility that the construction will result in numerous Public Service Commission complaints.

Obviously, both the expense and disruption would be multiplied in proportion to the anticipated expansion of fiber optic communications throughout the length and breadth of the State.

2. Operational/Safety Experience

The New York State Thruway Authority has permitted 40 longitudinal occupancies along the its right-of-way, at a total length of 23.6 miles with the first installation occurring in 1957. To date, no incidents have occurred that have caused hazardous situations during either installation or maintenance operations. Work permits must be issued by the New York State Thruway Authority prior to a company's access. In addition, New York State Thruway Authority staff supervises work insuring conformance to the New York State Thruway Authority's safety specifications. Twenty-nine years of such occupancy, without degradation to the safety of the motoring public or to the environment along the right-of-way, clearly demonstrates our success and absolute control over access.

In addition, there is no environmental impact beyond that which has been accepted with the construction of the Thruway itself. This conclusion stems from the simple fact that fiber optic installation would be accomplished within the Thruway's right-of-way and only property already owned by the Thruway would be affected. Since this is already dedicated to a public service function, the fiber optic installation would impact no further on the environment and certainly less than if the same property were to be used for vehicle transportation purposes. Nevertheless, the Thruway would continue to insist on the least possible disruption to wooded areas and the environment and intends to review construction and installations accordingly.

3. Importance to the State Economy

It is almost unnecessary to state that New York State's goal is to assure the availability of advanced, competitively priced telecommunication services to the individuals and firms doing business in the State. Incidentally, the New York State Thruway Authority, as an Agent of the State, is in turn committed to achieving that goal in any way it can.

This becomes clearer when it is understood that the maintenance of a competitively priced telecommunications system is particularly important to New York's economy because of the State's large concentration of information intensive industries which provide international as well as nationwide services. For more than a decade, service employment has been larger in New York State than manufacturing employment and the two most rapidly growing service sectors in New York State in the past fifteen years have been information and financial services. For example, while New York State accounts for only 9% of the nation's employment, it is responsible for 18% of the nation's insurance employment and more than 50% of the non-banking financial employment by foreign affiliates in the United States. Further, New York City, Long Island, and Westchester Counties accounted

Mr. R. A. Burnhart

4

January 9, 1980

for almost one-fourth of the nation's overseas message units in 1982. The information and financial service industries are heavily reliant on the rapid and secure transmittal of high volume information. In fact, they are far more reliant on the wires and ducts that move information than the roads and harbors that move goods. Constructing a fiber optic network also will have an important economic impact because of its "spillover", or multiplier effects. Several recent studies by Arthur D. Little and others estimate that a dollar spent in telecommunications infrastructure could create up to \$6 in new economic activity. This will provide a substantial boost to the State's economy, especially for businesses in finance, manufacturing and the services that can benefit from better communication links. In fact, the importance of telecommunications to manufacturing industries should not be overlooked. Advanced communications systems permit firms to concentrate their headquarters in one central location while dispersing manufacturing and other operations to locations outside the central city. This allows firms to establish regional or branch offices or plants to take advantage of labor and sales markets and still maintain rapid information links with headquarters over vital operating concerns such as production, inventories and marketing.

In this context it becomes apparent that the emergence of fiber optic communication networks across the nation, which are being designed to serve heavy communications traffic between large metropolitan regions, presents the Thruway and the State with a unique opportunity to serve economic development interests of the State. Any State government or institution in these circumstances would be remiss if they did not recognize that the conduits and right-of-ways of mass transit systems could be a valuable resource for the installation of fiber optic telecommunications systems.

4. The Thruway Advantage

The Thruway's contiguous right-of-way fits perfectly into New York's overall economic development scheme insofar as it relates to the emerging fiber optic communications networks. The Thruway maintains a contiguous highway that touches the State's east-west border and connects with its southern metropolitan region. In addition, it passes within miles of 80% of the State's population and connects almost all of its major urban centers, i.e. New York City, Westchester, Newburgh, Poughkeepsie, Kingston, Albany, Schenectady, Amsterdam, Utica, Syracuse, Rochester and Buffalo. Incidentally, the existing interstate system in New York State joins virtually all the major population centers.

It is apparent that the Thruway's right-of-way is the ideal resource for the State to consider in furthering the development of fiber optic communications systems - systems which

Mr. R. A. Barnhart

5

January 9, 1986

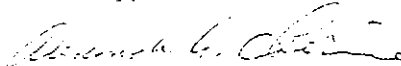
are being designed to serve heavy communications traffic between large metropolitan areas and are essential to New York's information and financial services industries.

5. Conclusion

While interstate right-of-ways were acquired and are maintained for highway transportation purposes, we do not feel that the societal changes and new technologies that are producing significant shifts to an information based society can be ignored. We view fiber optic installations as a largely trouble-free, compatible use of our right-of-way assets, that can also develop needed income to contribute to the existing toll and Federal funding sources to support the growing need to rehabilitate the highway and bridges comprising the New York State Thruway, "New York's Main Street." The well being of the State and the nation can also benefit from lightwave technology as it provides both by itself and as a supplement to microwave relay systems, satellites and earth stations currently in use efficient, economical communications which support the strategic resource that information represents.

If further information is necessary, please advise. Your prompt attention to this matter is sincerely appreciated.

Sincerely,



Executive Director

Attachment

Item 6

Survey of Governors



STATE OF NEW YORK
EXECUTIVE CHAMBER
ALBANY 12224

MARIO M. CUOMO
GOVERNOR

January 24, 1986

Dear //2//: (See attached list)

I am writing to bring to your attention an important economic development initiative which could be of great benefit to your state. The proposal, to allow the installation of fiber optic telecommunications cables along interstate highway rights-of-way, would dramatically upgrade your state's communications network, create savings for consumers, and increase employment opportunities.

On January 12 I appealed to U.S. Transportation Secretary Dole to waive an antiquated federal interstate highway right-of-way restriction and allow New York State to install fiber optic cable along the New York Thruway. A number of other states have also expressed interest in this issue.

However, the Federal Highway Administration (FHWA) currently restricts access to interstate rights-of-way under guidelines established in the 1950s to prevent their use by oil and gas pipelines and utility power lines. Such uses would have posed a threat to highway safety and accessibility. In contrast, a small fiber optic cable placed underground along an interstate right-of-way would not interfere with traffic during installation, and would be virtually maintenance-free.

Officials from my state have met with USDOT representatives on this issue. We intend to work with Secretary Dole to protect the integrity of the interstate highway system while advancing the application of this exciting new technology.

I have also discussed this matter with New York members of Congress. You may be interested to know that a congressional hearing on the issue will be scheduled in the near future.

-2-

I believe that the installation of fiber optic telecommunications cables along interstate highway rights-of-ways would represent an innovative economic development resource. I recommend that you examine the application and implications of this opportunity with your state's transportation and economic development experts. If you determine that the use of fiber optic cables could prove beneficial to your state, I encourage you to work with me in efforts to revise the outdated federal restrictions that now block access to the interstate rights-of-way.

Sincerely,

/s/ Mario M. Cuomo

//4 5 Name
6 7 Address
8 City, State
9
10 cc: Commissioner Franklin White, Department of Transportation
11// Governor G. Crotty E. Davis H. Dulles
 B. Johnson P. Bucklin M.A. Crotty E. Ryan
 M. Steadman Files (2)

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Item 7

FHWA Notice of Review

DEPARTMENT OF TRANSPORTATION**Federal Highway Administration****23 CFR Part 645****Accommodation of Utilities**

AGENCY: Federal Highway Administration (FHWA), DOT.

ACTION: Notice.

SUMMARY: The FHWA is issuing this notice to advise the public that it is reviewing its existing policy governing longitudinal utility use of Interstate (freeway) right-of-way (23a CFR 645, Subpart B) to determine if changes or modifications in this policy are needed. Present policy limits longitudinal utility use of the Interstate right-of-way within the access control limits. FHWA believes an overall review of policy is needed due to changes in technology and advancements in utilities configurations. FHWA will initiate the appropriate rulemaking in the near future requesting public comment.

FOR FURTHER INFORMATION CONTACT: James A. Carney, Office of Engineering, Federal Highway Administration, 400 Seventh Street, SW., Washington, D.C. 20590, Telephone: (202) 426-0450.

Issued on: March 27, 1986.

R.D. Morgan,

Executive Director, Federal Highway Administration

[FR Doc. 86-7303 Filed 3-31-86; 10:14 am]

BILLING CODE 4910-22-M

SOURCE: 51 FR 11055 (April 1, 1986).

Item 8

NASHTO Resolution

INTERSTATE HIGHWAY RIGHT-OF-WAY

WHEREAS, the creation of the Interstate Highway System has fundamentally advanced the movement of cargo and travelers throughout the nation by providing a safe and efficient transportation network; and

WHEREAS, the Interstate System has therefore contributed significantly to the nation's economic development and growth; and

WHEREAS, existing federal policy to preserve the integrity of the Interstate Highway System has limited longitudinal installation of utilities along Interstate rights-of-way; and

WHEREAS, these existing federal restrictions prohibit such installations only along Interstate rights-of-way, and not along other Federal Aid-Highway Systems; and

WHEREAS, allowing installation of such communications technologies can provide a boost to economic development by facilitating the transfer of information along Interstate routes and by providing additional funds for roadway improvements;

WHEREAS, traditional utility uses of the right-of-way have been appropriately discouraged because their installation and maintenance could interfere with Interstate Highways' primary purposes, technological advances hold the potential for joint facilities which are unobtrusive and require little or no maintenance; and

WHEREAS, fiber optics cables of minimal size can be placed underground, at the the edge of the right-of-way, and can be easily installed without generating interference with traffic and can be installed quickly compared to other kinds of facilities, and once installed, fiber optic cables are virtually maintenance-free unlike above ground utilities or other underground cables; and

WHEREAS, fiber optic systems do require repeater stations at intervals to maintain signal strength over long distances, the technology is improving rapidly and increasing the distance between repeater stations up to 50 miles, and even this minimal hazard could be avoided by placing repeater stations outside the right-of-way at interchanges or other locations;

NOW, THEREFORE BE IT RESOLVED THAT the Northeastern Association of State Highway and Transportation Officials (NASHTO), while reaffirming the objective of preserving the integrity and safety of the Interstate Highway System, supports the use of the existing Interstate Highway rights-of-way for the installation of fiber optic telecommunication cables where it can be demonstrated that such use will not interfere with the primary purpose of the Highways; and

Reaffirms its support for the basic principles of existing federal policy governing longitudinal installation of utilities along Interstate Highway rights-of-way; and

Urges the Federal Highway Administration to consider advances in communication technology and recognize the unique non-intrusive characteristics of fiber optics as warranting an exception to the existing rules and permit the use of Interstate Highway for installation of such unobtrusive systems at the option of the Governor upon submission to the Federal Highway Administration of a plan that ensures preservation of and adherence to existing safety standards and procedures; and

Urges the American Association of State Highway and Transportation Officials (AASHTO) to review its "Policy on the Accommodation of Utilities Within Freeway Right-of-Way" to recognize the unique public benefit of fiber optic installations and change the policy to grant to states the flexibility to permit such installations on Interstate routes and freeways; and

Urges that any provision for fiber optics shall be under standards and permits established by the individual states with the construction, operation and maintenance of such installations to be supervised by state highway officials in order to ensure the continued safety and preservation of the integrity of the Interstate Highway System; and

Encourages the Congress to review existing federal policies in light of the development of new communications technologies.

BE IT FURTHER RESOLVED THAT this Resolution be communicated to the American Association of State Highway and Transportation Officials, the Secretary of the United States Department of Transportation, and the Congress.

Approved on April 14, 1986 by the NASHTO Board of Directors
meeting in Atlantic City, New Jersey.

Item 9

Agenda for Initial Hearings in House

JOINT HEARING BEFORE THE
SUBCOMMITTEE ON ECONOMIC DEVELOPMENT
AND
SUBCOMMITTEE ON SURFACE TRANSPORTATION
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
U. S. HOUSE OF REPRESENTATIVES

TUESDAY, APRIL 15, 1986
ROOM 2167 RAYBURN HOUSE OFFICE BUILDING
10:A.M.

AGENDA

TO RECEIVE TESTIMONY ON THE SAFETY, LEGAL CONSEQUENCES, AND
ECONOMIC DEVELOPMENT BENEFITS OF PERMITTING THE INSTALLATION
OF FIBER OPTIC CABLE ALONG THE RIGHT-OF-WAY OF THE INTERSTATE
HIGHWAY SYSTEM

Mr. Richard D. Morgan, Executive Director
Federal Highway Administration
U.S. Department of Transportation

accompanied by: Mr. Larry Staron, Chief
Federal Aid Division

Mr. David Charlton, Marketing Manager
Telecommunications Products Division
Corning Glass Works, Corning, New York

Dr. Mitchell C. Moss, Associate Professor
New York University Graduate School of
Public Affairs

Mr. Allan V. Johnson, Executive Director
Ohio Turnpike Commission, Berea, Ohio

Mr. Wood Kinnard
Director of Right-of-Way Administration
U. S. Telecom, Inc., Shawnee Mission, Kansas

Mr. Paul C. O'Brien
Vice President of Customer Service
New York Telephone

Mr. Duane O. Christensen
Department of Transportation
Highway Division
State of Oregon

Speaking on behalf of the American Association
of State Highway and Transportation Officials

Item 10

Approval of New York Thruway Exception



U.S. Department
of Transportation
Federal Highway
Administration

Memorandum

Washington, D.C. 20590

Subject: New York - Request for Exception to Permit the
Installation of 5.99 Miles of Fiber Optic Cable
on New York Thruway Right-of-Way (Your May 28,
1986, Memorandum)

Date: June 19, 1986

From: Federal Highway Administrator

**Reply to
Att. of:** HNG-12

To: Mr. John G. Bestgen, Jr.
HRA-01 Regional Federal Highway Administrator
Albany, New York

We hereby concur in your planned action to grant a special case exception under the provisions of 23 CFR 645, Subpart B, to permit the above-referenced utility use conditioned upon provisions subsequently detailed in this letter.

The NYSDOT has determined that a prompt response is necessary to the public interest. Because of the unique urgency of this particular situation, this special case exception is not to be considered a precedent for future action.

Approval of the proposed utility use is subject to the following conditions:

- o Any future adjustments of the cable located within I-90 right-of-way necessitated by highway improvements will not be eligible for Federal participation.
- o The U.S. Secretary of Transportation and his/her agents and delegates shall be held harmless against any claims arising from the utility's use of I-90 right-of-way.

If the NYSDOT or the New York Thruway Authority are not amenable to these two added conditions, please inform this office.


R. A. Bernhart

Item 11

House Committee Report

"The Interstate System is a valuable transportation resource, and potentially, a valuable communications resource to the United States. The Committee recognizes that the installation of fiber optics telecommunications cables within Interstate highway rights-of-way would also represent an innovative economic development resource. The Subcommittees on Economic Development and Surface Transportation have begun hearings on the use of this advanced technology. While the Committee remains opposed to unlimited access to Interstate rights-of-way by every utility, it appears that a great deal can be gained by accommodating fiber optic cables with little appreciable negative effect on traffic or safety. It is the understanding that the Federal Highway Administration is presenting conducting a review of the current restrictions on the use of Interstate rights-of-way. It is also the understanding of the Committee that FHWA has announced its approval of the New York State Thruway's request to install a fiber optic cable along a segment of the Thruway. The Committee recommends that the Secretary complete her review as expeditiously as possible. In making her determination as to whether fiber optic cables should be permitted along Interstates, the Secretary should fully consider the unique and unobtrusive characteristics of fiber optic installations. Installation shall not be permitted where it can be demonstrated that such use will adversely affect safety or interfere with or impair the operation of the highways. The Committee does believe that if Interstate right-of-way is to be used for the installation of fiber optic cable, consideration must be given to the economic interest of the public, and that the public interest is best served by the preservation of competition. The installation of fiber optic cable in Interstate right-of-way must not result in the inhibition of competition in a service area, a goal which might be achieved if the cable operator is required to serve as a common carrier."

SOURCE: *Federal Highway Act of 1986*, Report of the Committee on Public Works and Transportation, United States House of Representatives, 99th Congress, 2d session, Report 99-665, July 2, 1986, p. 3.

Item 12

Senate Committee Report

"The installation of fiber optics telecommunications cables within Interstate highway rights-of-way presents States with important economic development opportunities. While unlimited access to Interstate rights-of-way by every utility is not desirable, it appears that benefits might be able to be obtained by accommodating fiber optic cables without a negative effect on traffic or safety. DOT is presently conducting a review of the current restrictions on the use of Interstate rights-of-way and has recently approved the State of New York's request to install a fiber optic cable along a segment of the New York Thruway. The Committee recommends that DOT complete its review as expeditiously as possible. In making the determination as to whether fiber optic cables should be permitted along the Interstate System, the Secretary should give full consideration to the unique and unobtrusive characteristics of fiber optic installation and its benefits."

SOURCE: *Federal Highway Act of 1986*, Report of the Committee on Environment and Public Works, United States Senate, 99th Congress, 2d session, Report 99-369, August 4, 1986, p. 5.

Item 13

23 CFR 1.23: Rights-of-Way

§ 1.23 Rights-of-way.

(a) *Interest to be acquired.* The State shall acquire rights-of-way of such nature and extent as are adequate for the construction, operation and maintenance of a project.

(b) *Use for highway purposes.* Except as provided under paragraph (c) of this section, all real property, including air space, within the right-of-way boundaries of a project shall be devoted exclusively to public highway purposes. No project shall be accepted as complete until this requirement has been satisfied. The State highway department shall be responsible for preserving such right-of-way free of all public and private installations, facilities or encroachments, except (1) those approved under paragraph (c) of this section; (2) those which the Administrator approves as constituting a part of a highway or as necessary for its operation, use or maintenance for public highway purposes and (3) informational sites established and maintained in accordance with § 1.35 of the regulations in this part.

(c) *Other use or occupancy.* Subject to 23 U.S.C. 111, the temporary or permanent occupancy or use of right-of-way, including air space, for nonhighway purposes and the reservation of subsurface mineral rights within the boundaries of the rights-of-way of Federal-aid highways, may be approved by the Administrator, if he determines that such occupancy, use or reservation is in the public interest and will not impair the highway or interfere with the free and safe flow of traffic thereon.

Item 14

23 USC § 109: Federal-Aid Highways/Standards

§ 109. Standards

(a) The Secretary shall not approve plans and specifications for proposed projects on any Federal-aid system if they fail to provide for a facility (1) that will adequately meet the existing and probable future traffic needs and conditions in a manner conducive to safety, durability, and economy of maintenance; (2) that will be designed and constructed in accordance with standards best suited to accomplish the foregoing objectives and to conform to the particular needs of each locality.

(b) The geometric and construction standards to be adopted for the Interstate System shall be those approved by the Secretary in cooperation with the State highway departments. Such standards, as applied to each actual construction project, shall be adequate to enable such project to accommodate the types and volumes of traffic anticipated for such project for the twenty-year period commencing on the date of approval by the Secretary, under section 106 of this title, of the plans, specifications, and estimates for actual construction of such project. Such standards shall in all cases provide for at least four lanes of traffic. The right-of-way width of the Interstate System shall be adequate to permit construction of projects on the Interstate System to such standards.

The Secretary shall apply such standards uniformly throughout all the States.

(c) Projects on the Federal-aid secondary system in which Federal funds participate shall be constructed according to specifications that will provide all-weather service and permit maintenance at a reasonable cost.

(d) On any highway project in which Federal funds hereafter participate, or on any such project constructed since December 20, 1944, the location, form and character of informational, regulatory and warning signs, curb and pavement or other markings, and traffic signals installed or placed by any public authority or other agency, shall be subject to the approval of the State highway department with the concurrence of the Secretary, who is directed to concur only in such installations as will promote the safe and efficient utilization of the highways.

(e) No funds shall be approved for expenditure on any Federal-aid highway, or highway affected under chapter 2 of this title, unless proper safety protective devices complying with safety standards determined by the Secretary at that time as being adequate shall be installed or be in operation at any highway and railroad grade crossing or drawbridge on that portion of the highway with respect to which such expenditures are to be made.

(f) The Secretary shall not, as a condition precedent to his approval under section 106 of this title, require any State to acquire title to, or control of, any marginal land along the proposed highway in addition to that reasonably necessary for road surfaces, median strips, bikeways, gutters, ditches, and side slopes, and of sufficient width to provide service roads to adjacent property to permit safe access at controlled locations in order to expedite traffic, promote safety, and minimize roadside parking.

(g) The Secretary shall issue within 30 days after the day of enactment of the Federal-Aid Highway Act of 1970 guidelines for minimizing possible soil erosion from highway construction. Such guidelines shall apply to all proposed projects with respect to which plans, specifications, and estimates are approved by the Secretary after the issuance of such guidelines.

(h) Not later than July 1, 1972, the Secretary, after consultation with appropriate Federal and State officials, shall submit to Congress, and not later than 90 days after such submission, promulgate guidelines designed to assure that possible adverse economic, social, and environmental effects relating to any proposed project on any Federal-aid system have been fully considered in developing such project, and that the final decision on the project are made in the best overall public interest, taking into consideration the need for fast, safe and efficient transportation, public services, and the costs of eliminating or minimizing such adverse effects and the following:

- (1) air, noise, and water pollution;
- (2) destruction or disruption of man-made and natural resources, aesthetic values, community cohesion and the availability of public facilities and services;
- (3) adverse employment effects, and tax and property values losses;

- (4) injurious displacement of people, businesses and farms; and

(5) disruption of desirable community and regional growth. Such guidelines shall apply to all proposed projects with respect to which plans, specifications, and estimates are approved by the Secretary after the issuance of such guidelines.

(i) The Secretary, after consultation with appropriate Federal, State, and local officials, shall develop and promulgate standards for highway noise levels compatible with different land uses and after July 1, 1972, shall not approve plans and specifications for any proposed project on any Federal-aid system for which location approval has not yet been secured unless he determines that such plans and specifications include adequate measures to implement the appropriate noise level standards. The Secretary, after consultation with the Administrator of the Environmental Protection Agency and appropriate Federal, State, and local officials, may promulgate standards for the control of highway noise levels for highways in any Federal-aid system for which project approval has been secured prior to July 1, 1972. The Secretary may approve any project on a Federal-aid system to which noise-level standards are made applicable under the preceding sentence for the purpose of carrying out such standards. Such project may include, but is not limited to, the acquisition of additional rights-of-way, the construction of physical barriers, and landscaping. Sums apportioned for the Federal-aid system on which such project will be located shall be available to finance the Federal share of such project. Such project shall be deemed a highway project for all purposes of this title.

(j) The Secretary, after consultation with the Administrator of the Environmental Protection Agency, shall develop and promulgate guidelines to assure that highways constructed pursuant to this title are consistent with any approved plan for the implementation of any ambient air quality standard for any air quality control region designated pursuant to the Clean Air Act, as amended.

(k) The Secretary shall not approve any project involving approaches to a bridge under this title, if such project and bridge will significantly affect the traffic volume and the highway system of a contiguous State without first taking into full consideration the views of that State.

(1)(1) In determining whether any right-of-way on any Federal-aid system should be used for accommodating any utility facility, the Secretary shall—

(A) first ascertain the effect such use will have on highway and traffic safety, since in no case shall any use be authorized or otherwise permitted, under this or any other provision of law, which would adversely affect safety;

(B) evaluate the direct and indirect environmental and economic effects of any loss of productive agricultural land or any impairment of the productivity of any agricultural land which would result from the disapproval of the use of such right-of-way for the accommodation of such utility facility; and

(C) consider such environmental and economic effects together with any interference with or impairment of the use of the highway in such right-of-way which would result from the use

of such right-of-way for the accommodation of such utility facility.

(2) For the purpose of this subsection—

(A) the term “utility facility” means any privately, publicly, or cooperatively owned line, facility, or system for producing, transmitting, or distributing communications, power, electricity, light, heat, gas, oil, crude products, water, steam, waste, storm water not connected with highway drainage, or any other similar commodity, including any fire or police signal system or street lighting system, which directly or indirectly serves the public; and

(B) the term “right-of-way” means any real property, or interest therein, acquired, dedicated, or reserved for the construction, operation, and maintenance of a highway.

(m) The Secretary shall issue guidelines describing the criteria applicable to the Interstate System in order to insure that the condition of these routes is maintained at the level required by the purposes for which they were designed. The initial guidelines shall be issued no later than October 1, 1979.

(n) The Secretary shall not approve any project under this title that will result in the severance or destruction of an existing major route for nonmotorized transportation traffic and light motorcycles, unless such project provides a reasonably alternate route or such a route exists.

(o) It is the intent of Congress that any project for resurfacing, restoring, or rehabilitating any highway, other than a highway access to which is fully controlled, in which Federal funds participate shall be constructed in accordance with standards to preserve and extend the service life of highways and enhance highway safety.

Item 15

FHWA Notice of Proposed Rulemaking

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

23 CFR Part 645

[FHWA Docket No. 86-15]

Accommodation of Utilities; Longitudinal Utility Use of Freeway Right-of-Way

AGENCY: Federal Highway
Administration (FHWA), DOT.

ACTION: Notice of proposed rulemaking.

PART 645—UTILITIES

Subpart B—Accommodation of Utilities

The FHWA proposes to amend 23
CFR Part 645, Subpart B as follows:

1. The authority citation for Part 645,
Subpart B continues to read as follows:

Authority: 23 U.S.C. 109 and 119; 23 CFR
1.23 and 1.27; and 49 CFR 1.48(b); Executive
Order 11990, 42 FR 26061 (May 24, 1977).

2. Section 645.209 is amended by
revising paragraph (c) to read as
follows:

§ 645.209 General Requirements.

(c) *Installations within freeways.* (1) Since the preservation of the control of access feature of freeways is essential to the safe and efficient use of such highways, new longitudinal utility installations within the access control lines of a freeway may be permitted only under strictly controlled conditions. Such installations may be considered for approval only in special cases where the following two conditions are met.

(i) The State highway agency can show that the accommodation within the control of access lines is the most feasible and prudent location available. This includes a showing that:

(A) Alternate locations would be unreasonably costly from the standpoint of providing efficient utility services in a

manner conducive to safety, durability and economy of maintenance and operations, or

(B) Alternate locations are not available or would be extremely difficult to implement, or

(C) Alternate locations would adversely impact or impair the productivity of agricultural land.

(ii) The State highway agency is able to demonstrate that the accommodation will not adversely affect the safety, design, construction, operation, maintenance and stability of the freeway. This includes a showing that:

(A) There is adequate right-of-way available which is not needed for planned highway expansion,

(B) The proposed installation will not interfere with the present and future use of the freeway, and

(C) The installation will not be constructed and/or serviced by direct access from the through traffic roadways or connecting ramps, except that utilities may be constructed and/or serviced from through roadways and ramps within interchange and other areas provided that all of the conditions of this subpart are met; that other means of access are not practically available, and that such access is controlled by permits issued by the highway agency setting forth the conditions for policing and other controls to protect highway users.

(2) Utility installations on freeway right-of-way shall conform to the provisions of the AASHTO publication "A Policy on the Accommodation of Utilities Within Freeway Right-of-Way" 1982, except as modified herein. (With the exception of Item 2, this publication is incorporated by reference and is on file at the Office of the Federal Register in Washington, DC. It is available for inspection from the FHWA Washington Headquarters and all FHWA Division and Regional Offices as prescribed in 49 CFR Part 7, Appendix D. Copies of current AASHTO publications are available for purchase from the American Association of State Highway and Transportation Officials, Suite 225, 444 North Capitol Street, NW., Washington, DC 20001.

(3) Nothing in this part shall be construed as prohibiting a highway agency from adopting a more restrictive policy than that contained herein with regard to longitudinal utility installations along freeway right-of-way and access for constructing and/or servicing such installations.

3. Section 645.211 is amended by adding a new paragraph (e) as follows:

§ 645.211 State highway agency accommodation policies.

(e) At the State highway agency's option, it may establish terms and conditions and/or procedures for longitudinal installations on Federal-aid freeways, that provide for class approval of certain utilities that meet each of the conditions set forth in § 645.209(c) of this part. Where this occurs, the State highway agency's utility accommodation policy must clearly set forth the criteria and performance standards necessary for a utility to qualify for such approval or procedures.

4. Section 645.215 is amended by revising paragraph (d)(2) to read as follows:

§ 645.215 Approvals.

(d) . . .

(2) Longitudinal installations on Federal-aid freeways meeting the conditions cited in § 645.209(c) of this part except for those installations approved by the State under the procedures established by § 645.211(e) of this part.

[FR Doc. 86-28506 Filed 12-18-86; 8:45 am]
BILLING CODE 4910-22-M

Appendix D

CONSULTANT'S REPORT: ASSESSING THE POTENTIAL EFFECT OF FIBER-OPTICS INSTALLATIONS ON INTERSTATE TRAFFIC FLOW AND SAFETY

Don H. Jones, Assistant Director
Transportation Center, University of Tennessee

The Interstate highway system in the United States is the safest highway system in the world. There are a number of contributing factors to this safety record. One major factor is that no activity is permitted within the rights-of-way unless it directly contributes to the operation of the highway. For this reason, utilities are not permitted to occupy the rights-of-way except for necessary crossings and at very isolated places where great hardships are encountered. The system has also been improved since its beginning by two primary actions. The first was the removal of, or protection against, fixed objects, i.e., light poles, sign posts, culvert end walls, bridge piers, etc. The second one was the institution of the 30-ft clear zone. There are alternatives for dealing with these elements, none of which are as safe and as satisfactory as the primary intent of maintaining an absolute, object-free, 30-ft clear zone from the edge of the pavement.

A few years ago, the author made a study of utility poles set in the median of Interstate highways for utility crossings. Surprisingly, although there are not very many of these installations, some had been struck. This is an indication that objects on the side of the road and in the median will be struck. Construction equipment and maintenance equipment closely mimic fixed objects when operating or left unattended along the highway. Construction and maintenance operations, especially along high-volume segments of the Interstate system, have caused such serious problems with the traveling public that many special precautions and safe operating procedures have been instituted by the Federal Highway Administration (FHWA). These precautions include improved signing, flagging, detours, pavement marking, visibility, and use of protective devices and barriers such as attenuators, New Jersey barriers, and special lighting. Even with these added extra precautions, accidents still occur, probably because Interstate highways are expected to be free flowing and unimpeded.

The image and credibility of utility agencies are not good with most highway agencies regarding the management of traffic through work zones and restoration of damage to pavements, ditches, landscape, fences, etc. These are major concerns, as pointed out by individual states; however, it is to be noted that the Florida Turnpike Authority reported a very successful relationship with AT&T in the installation of the coaxial cable and fiber-optics duct in the median of the Florida Turnpike. One must carefully note the conditions that exist in Florida in working with utilities before drawing any conclusions (see the section below on Florida).

There are issues beside safety and reduced capacity that concern highway agencies regarding potential installations of fiber-optics cable in Interstate highway rights-of-way. Installations on bridges and underwater crossings are areas where problems can be expected to occur. Work in medians takes place near high-speed lanes where distractions are least desirable. Better information is needed about future maintenance of fiber-optics cable and appurtenances. It appears that future needs are being taken care of for both capacity and expansion; however, some seems to have occurred by accident through technological advances and not from careful planning. Proliferation, first of different companies putting in fiber-optics cable, and next of all utilities, seems to be the most feared concern of highway agency employees, especially in view of the strong push for transportation corridors that would include utilities with the Interstate highways forming the main right-of-way core. This concept has been promoted extensively for many years and is expected to intensify with the advent of fiber-optics installations in Interstate highway rights-of-way, should it occur.

Highway capacity will be temporarily affected during fiber-optics installations and maintenance. Reduced capacity translates to longer peak traffic periods over the duration of the operation. But there are other considerations when traffic flow and capacity are impeded. Capacity and traffic flow are disturbed, or the balance of flow interrupted, with any operation taking place near a fast-moving traffic lane. If any restrictions occur, changes can be expected in the flow of traffic. People and equipment working next to moving traffic cause changes also. Drivers can quickly become tense, stressed, and frustrated under restricted conditions and may increase speed, as borne out by studies conducted by the Federal Highway Administration, setting up the potential for more serious accidents. Some restrictions cause drastic slowdowns in traffic flow. In any of these end results, accidents, especially rear-end collisions, will increase, delays occur, and more fuel will be consumed. Any object six feet or closer to moving traffic will cause lateral movement of vehicles and reduced capacity. The *Highway*

Capacity Manual, Transportation Research Board Special Report 209, is the reference manual for analyzing capacity potential of highways.

Care must be used in generalizing about utility installations within Interstate highway rights-of-way. For instance, in many remote rural areas where wide medians (over sixty feet) exist and there is substantial acreage on each side of the highway, installations would probably have no discernible impact on traffic. Yet it would be virtually impossible to restrict installations to just these areas. One cannot generalize that simply because an installation went without incident in one location, no problems should be expected with installations at other locations.

ACCIDENT STATISTICS

Overall

The data in Table D.1 were taken from the U.S. Department of Transportation's (DOT's) Fatal Accident Reporting (FAR) System and the monthly and annual highway accident reports published by the Federal Highway Administration. The 1984 statistics are the latest ones available. In 1983, the number of accidents per 100 million vehicle miles traveled (VMT) were the lowest ever recorded. The total number of fatalities has been climbing slowly since 1983, but the rate per 100 million VMT has remained about the same. A slight increase in fatalities on the Interstate highway system has been attributed to increased involvement of heavy trucks.

Table D.1

ACCIDENT AND FATALITY DATA FOR 1984

	All Roads	Interstate
Accidents		
Fatal	39,622	3,590
Nonfatal	2,150,000	128,468
Total	2,189,622	132,058
Fatalities	44,241 ^a	4,298
Total miles traveled (VMT)	1717×10^9	352×10^9
Fatalities per 100,000,000 VMT	2.58	1.20

^aThe year ending June 30, 1986, shows 44,400 fatalities (*Highway Safety Facts*, U.S. Department of Transportation).

For every fatality on the Interstate, five occurred on other arterials, yet travel on the Interstate is two-and-one-half times greater than on other arterials ("arterials" do not include local connectors, streets, and rural country roads).

Utility Installations

The only fatal accident data available with respect to utility installations on freeways are those associated with utility poles (other than dedicated light standards). As indicated in Table D.2, even though there are relatively few utility poles in freeway ROW, there has been a surprising number of fatal accidents.

Construction and Maintenance Zones

Data regarding fatal accidents in construction and maintenance zones are shown in Table D.3. Despite the fact that the overall fatality rate (per 100 million VMT) on Interstates is less than half that on all other road systems and total Interstate mileage is only 1.1 percent of total U.S. road mileage, roughly 20 percent of all construction/maintenance zone fatal accidents occur on Interstates. To some extent this result is probably attributable to the higher sustained rate of speed on Interstate highways in conjunction with the fact that motorists do not anticipate interruptions on Interstates as they do on other road systems. One point quite evident from these data is that when any operation takes place on the Interstate highway system that conflicts with traffic, serious consequences can be expected.

Table D.2

FATAL ACCIDENTS INVOLVING UTILITY POLES ON INTERSTATE FREEWAYS

Year	Fatalities	Accidents
1979	34	30
1978	20	20
1977	18	15
1976	26	26
1975	23	22

SOURCE: Special request of FAR system,
May 1980.

Table D.3

**FATAL ACCIDENTS IN CONSTRUCTION/MAINTENANCE ZONES
BY FUNCTIONAL CLASSIFICATION**

	Road Construction Zone		Road Maintenance Zone		Utility Zone		Unknown Work Zone		Total	
	1983	1984	1983	1984	1983	1984	1983	1984	1983	1984
Interstate	101	66	20	20	0	0	19	20	140	106
Other freeway & expressway	19	22	5	3	0	0	7	5	31	30
Other principal arterial	97	98	26	14	1	2	28	13	142	127
Minor arterial	70	75	9	14	1	0	15	17	95	106
Collector	42	78	9	8	4	3	11	8	66	97
Local	37	44	6	2	4	0	7	4	54	50
Unknown	2	0	1	0	0	0	0	0	3	0
Total	368	483	66	61	10	5	87	67	531	516

SOURCE: FAR system report for 1983 and 1984, U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, D.C., published 1985 and 1986.

ANTICIPATED EFFECTS

In discussing the effect of fiber-optics installations on Interstate highway safety and traffic flow, one must consider that traffic movements, especially at peak periods, cannot be equated from region to region. There is little change in traffic flow between peak periods and off-peak periods in many parts of the country, particularly in the Northeast, Atlanta, Chicago, California, parts of Florida and Texas, New Orleans, and other urban areas; nor can rural traffic in these areas be equated to that in most of the Western and Midwestern states. In any area, interference with traffic during rush hour or peak periods will result in the most delays, traffic jams, and accidents. Accidents during these periods tend to be less serious than those at off-peak times, but far more frequent. Increased speeds during off-peak periods probably account for the increased seriousness of accidents at these times.

Work in the median will always present the worst scenario due to higher speeds in the lanes next to the median and the idea that the median is a safe place to maneuver a vehicle when trouble occurs. The shoulder area is the next worst place to be, especially if the shoulder is occupied with equipment; it is an emergency area for errant or crippled vehicles. The closing of a traffic lane at any time on most Interstate

highways results in serious delays, backups, and conflicts in weaving that provide the greatest potential for accidents. Most of the fiber-optics installations on toll highways have resulted in lane closures. Work near the fence line should be less obstructive to traffic flow and should cause little or no interference if the fence is moved in and the fiber-optics cable placed outside the fence.

It is difficult to predict the nature of accidents that will result in fatalities. Of course, the higher the speed of vehicles involved in accidents, the increased likelihood of fatalities. However, fatalities occur at low speeds in head-on collisions and in collisions with fixed objects and construction equipment. Objects on construction equipment and work trucks have a tendency to penetrate automobiles, resulting in more serious accidents. Collisions with blunt objects such as the blunt face of a New Jersey barrier also can result in serious accidents. Night and adverse weather conditions are very poor times to set up work zones near moving traffic anywhere.

In rural areas speeds are higher, and drivers are more relaxed and often less alert, so that accidents can be much more serious. Accidents will probably occur more often in urban areas in work zones because of high traffic volumes, more weaving maneuvers, and resulting conflicts. There are no good places to conduct construction work and maintenance operations inside the access control fences of Interstate highways. Moreover, as shown in Table D.4, travel is expected to increase substantially.

EXPERIENCE OF STATES HAVING OR ANTICIPATING FIBER-OPTICS INSTALLATIONS ON FREEWAYS

New York

Apparently old copper cable installations were begun in New York on the off freeway system in the mid-1960s. Highway Department employees relate this system to the new fiber-optics system and see the same problems occurring. Their experience with the new fiber-optics cable also indicates that recurring periodic maintenance will be required more often than industry predicts. Serious problems are expected with moisture penetration, although it seems to be less of a problem today than in the past. Considerable footage of fiber-optics cable is aerial or on poles; there is probably more aerial than underground. This could be a serious problem if ever permitted in Interstate highway rights-of-way.

Table D.4
TRAFFIC PROJECTIONS

Projections
Urban travel is increasing at a rate of 4 percent per year.
The 37 largest metropolitan areas in the United States are experiencing over 1.2 billion vehicle-hours of delay per year on freeways alone.
A 50 percent increase in travel demand is projected for urban freeways between the years 1984 and 2005.
A 200 percent increase in recurring congested travel is forecasted during this period which, in effect, will extend the time for peak periods.
A 400 percent increase in delays is expected.
Conditions of projections
New (added) facilities will handle only one-quarter of demand.
There will be no change in freeway operations such as permitting utility installations that might add to congestion.
There will be no changes in world conditions that would adversely affect travel demand such as a cutoff of Arabian oil supplies.

SOURCE: Federal Highway Administration and Transportation Research Board.

Many problems have been encountered with installations of the new fiber-optics cable. There has been a consistent lack of proper signing, warning, and protection at both installation and maintenance sites. There is a failure to properly backfill and compact soil and to properly repair damaged base and pavement where shoulders and pavements are interfered with. There are serious problems with reliability and dependability; for instance, workers have moved from back of slopes to shoulder without permission. Utility agencies are not keeping good records of precise locations. Attachments to bridges have resulted in problems causing almost continuous maintenance on fiber-optics cables. They have apparently been unable to properly ground conduits and to protect against expansion and contraction of the bridges. Underwater installations have serious problems with moisture penetration which have not been solved; in some instances, utility maintenance vehicles have to use freeway rights-of-way to reach underwater stream crossings. Highway maintenance forces have cut underground

cables, usually around drainage structures and in ditch lines, and have driven guardrail posts through them because the location of the fiber-optics cable was not known. Aerial installations present typical utility pole problems which are now well documented. There has been trouble with bores under highways typical of this type utility installation. There have been numerous problems and considerable maintenance at regenerator stations and splicing manholes.

The New York DOT expects numerous requests for more permits on thruways and freeways until fiber optics are installed on the entire length. Lawsuits are expected by other agencies installing fiber-optics cable (Sprint, etc.) for the same installation privilege as New York Telephone. Next, suits are expected to be filed to open up the Interstate highway rights-of-way to all utilities, since New York state legislation permits utilities to occupy highway rights-of-way. The DOT fully expects all utilities to pressure the state for occupancy rights (if one gets on, there is no way to keep others out). It is expected that the fiber-optics group will pressure the NY DOT, the legislature, and the administration to permit aerial installations on freeways, particularly where rough, rocky terrain is encountered.

Florida

The Florida experience with fiber-optics installation on the Florida Turnpike was very good. In general, though, Florida DOT employees are opposed to opening up freeways to fiber-optics installations—especially on Interstate highways. The Florida DOT has been the leader in developing policies and procedures for working with utility agencies; they are probably far ahead of any other state in this regard. They have a one-call system and were one of the first to initiate it. They have developed probably the best liaison system between the Florida DOT, contractors, and utility agencies. They have developed a no-cost approach that requires an in-depth study of any conflict between utilities and highway work or operations in an effort to eliminate the need to adjust utility facilities. These excellent working relationships exist between almost all governmental agencies and utility agencies in Florida. All parties involved have worked hard to develop a smooth relationship. To the knowledge of the author, this kind of working relationship has not been developed to this degree in any other state. Although the Florida DOT was the leader, it has had the cooperation of all parties, especially Florida Power and Light and AT&T.

The Florida Turnpike Authority, now under Florida DOT, entered into a contract with AT&T which covered the fiber-optics installation

and the handling of traffic. The Authority reported that AT&T did more from a safety standpoint of handling traffic than was required. The Turnpike Authority reported that they were not aware of the occurrence of any problems except for one minor incident with the seeding and sodding contractor that did not affect the safety of the traveling public. AT&T stopped work until the situation was remedied. AT&T reported one minor accident. A subcontractor set up a cone line to protect the work site (a cable placed in the median) but did not block off a lane. The cones were set at the white edge line next to the median. A vehicle struck one of the cones, knocking it into a worker and slightly injuring him. He underwent a medical check and was permitted to return to work.

AT&T hired off-duty highway patrolmen to be on the job site during all working hours. This is one of the most effective means of working traffic. They blocked one traffic lane next to the workers. AT&T installed the cable at a rate of 5000 to 40,000 feet per day (one mile to eight miles per day). Typical construction signing, cones, arrowing boards, and flagmen were used around the construction site.

Closing one lane restricted traffic flow and reduced the lanes from two to one, or from three to two, in one direction and on one side. It was no longer a free-flowing highway, and traffic backed up and delays did occur. The one to eight mile per day installation rate applied to the cable only and not to totally clearing the construction zone.

Work hours were not restricted by contract, but AT&T voluntarily adjusted times to interfere with traffic flow as little as possible. Additionally, the contract permitted splicing manholes in the median, lane closures for emergency maintenance, attachments to bridges in some instances, and installation of additional cable.

Massachusetts

The State Police were at the work site during all installation operations of the fiber-optics cable on the Massachusetts Turnpike. No accidents or unusual problems with traffic could be recalled. Working times were restricted to nonrush hours. Traffic records are not computerized, and hand tallies by location and date would have to be made for the period of the installation to determine if any accidents occurred.

There was little information about installation and maintenance of the fiber-optics cable or about accidents, delays, congestion, or traffic interference during the installation. Although the Department of Transportation was not involved in the actual installation, they felt

that delays and backups did occur and were generally opposed to installation work on the Interstate highway system.

Georgia

Georgia does not permit freeway installations of utilities except for crossings and special hardship cases. They have not conducted any studies on the effects of such installations on highway capacity. They restrict working hours of any utility installation on all highways.

Georgia has experienced problems with traffic control and the use of warning devices by utility agencies during maintenance and installation of facilities. The Department is not always notified of maintenance work. Problems have also been experienced with compacting and back-filling trenches and repair of pavement cuts. Fixed objects such as poles and parked and operating equipment have presented hazards.

Georgia is strongly opposed to the installation of any utility facilities, including fiber-optics cable, on freeway rights-of-way.

Kansas

Kansas faces a proposed Interstate 70 installation of fiber-optics cable. Officials were careful to preface their remarks concerning the installation. On this particular installation, the state will control the work. It is certain that capacity will be affected during installation and maintenance operations but no studies have been conducted by Kansas to verify this. Reliance is on experience and the *Highway Capacity Manual*.

Their concerns include past lack of good traffic control and warning signs during construction by utility agencies.

Kansas is looking seriously at the possibility of eliminating the state WATS system and replacing it with the fiber-optics system as a trade-off for the right to install the cable on Interstate rights-of-way. This would result in a very large economic benefit.

Ohio and Indiana

Comments from these states were generally the same as those from Massachusetts and other states. A comment was made that where rough, difficult terrain was encountered, the fiber-optics cable was routed away from the freeway to private or other property and buried. Agencies installing fiber-optics cable seem to prefer to bury the cable rather than go to aerial or pole installation.

Minnesota

The Minnesota DOT is working with Northwestern Bell on a test installation of a fiber-optics cable in the median of an expressway (not freeway). The expressway is located in a rural area and has intersections. The traffic volume is low. The cable is being installed in the 40-ft-wide median. The cable has to be 48 inches below the bottom of the median ditch and must be installed in a bored casing under all crossovers. The Minnesota DOT required traffic control in compliance with the *Manual on Uniform Traffic Control Devices* (MUTCD) and in accordance with their own manual which is somewhat stricter than the MUTCD. Northwestern Bell is responsible for the traffic control. The test project will consist of installation at two sites on the expressway. In general, the first installation, now under way, has not interfered with traffic movements. All lanes are kept open during construction because of the wide medians. There has not yet been enough experience with fiber-optics cable installations to draw any firm conclusions about adverse effects. But it was made clear that this is a test section only, and that there is no intent, at this time, to permit such installations on the Interstate highway system in Minnesota.

CLOSELY RELATED HIGHWAY OPERATIONS

As a reference, there are some operations on Interstate highways that are closely related to the proposed fiber-optics installations. The best one probably is the installation of drains at the edge of the pavement (see Figs. D.1-D.5). Traffic control is carefully set up and managed in installations of this nature by highway departments. The motivation for contractors to maintain good signing and traffic control is strict contractual requirements, close inspection by the state DOT and the Federal Highway Administration, and pay for the activity. These edge or under drains can be put in at the rate of about one mile per day. The traffic lane next to the shoulder or work area is usually, but not always, closed during the installation. Sometimes, traffic may have to be crossed over, making one side of the Interstate highway two-directional through the work zone. Such installations play havoc with traffic movements and cause serious congestion, delays, and back-ups, especially if a lane is closed. Accidents do occur occasionally. They are generally of two types: collisions with traffic control devices (cones, arrowboards, barrels, attenuators, signs, and other type barricades or carriers); and rear-end collisions between vehicles. These installations are usually of short duration and traffic interference lasts only four to six weeks. Pavement edge drains are generally installed in

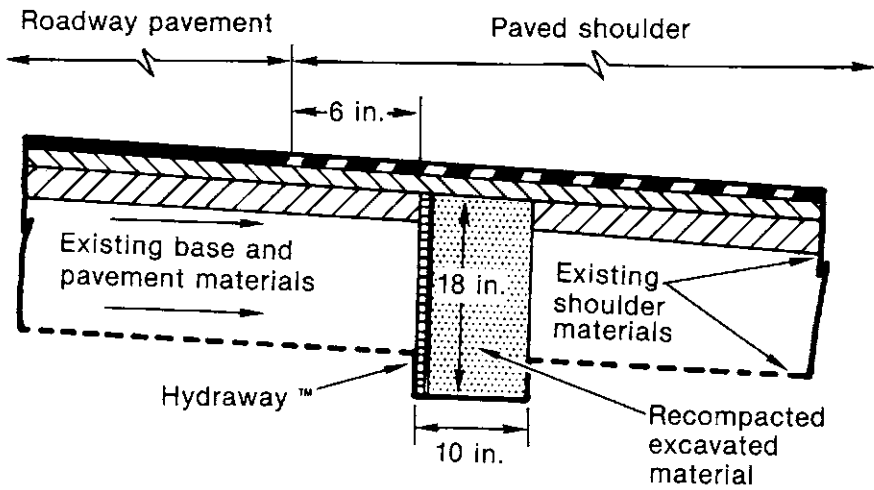


Fig. D.1—Typical placement of edge drains

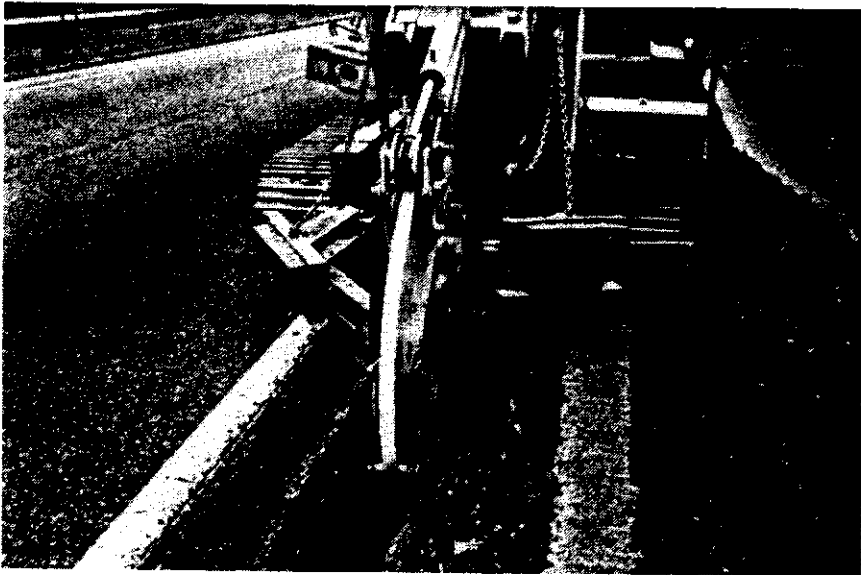


Fig. D.2—Edge drain trenching machine



Fig. D.3—Placing the edge drain pipe

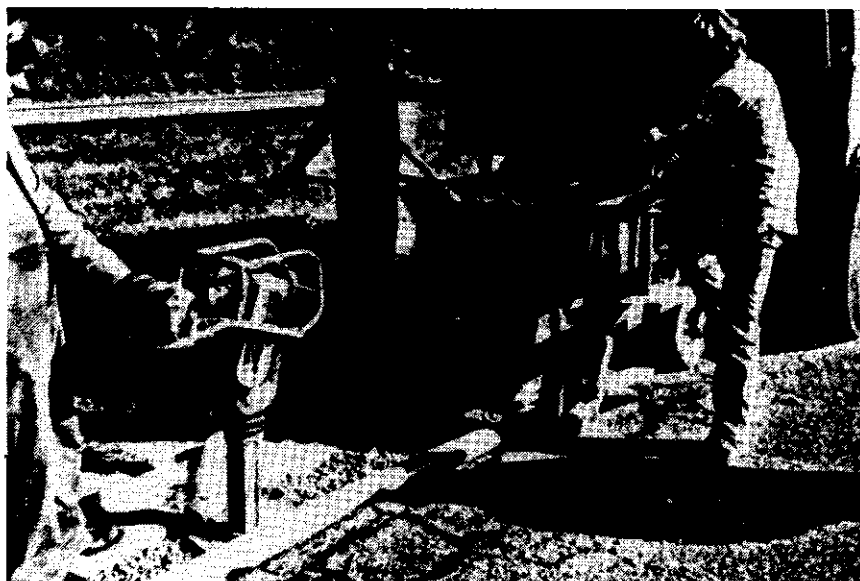


Fig. D.4—Backfilling the trench

rural, or in light or fringe urban areas. They are difficult to install in metropolitan areas if storm drain systems are complex.

Efforts have been made to correlate the proposed fiber-optics installations with other operations on freeways or Interstate highways. Pavement striping, for example, is a moving operation with a work train. Many miles of striping are put down per day. Warning signs, orange cones, arrowboards, and towed attenuators are set up. The work is done during off-peak periods and usually in the opposite direction of the peak flow. Some serious accidents have resulted from these operations. One such accident witnessed by the author involved the total destruction of a gasoline tanker truck (an eighteen-wheel tractor/trailer), and damage to two automobiles, some of the painting equipment, a storm sewer, and property along a stream into which



Fig. D.5—Preparation for repaving the pavement cut

burning gasoline flowed. Deaths and serious injuries connected with this operation have occurred around the country. Both Tennessee and North Carolina have experienced recent fatalities. Interference with traffic flow during striping results in congestion, delays, and backups of traffic. But striping is not a good analogy because it takes place on an annual or biannual basis, center lane striping is in the main stream of traffic encroaching on both lanes, and edge striping affects at least one lane. This is an extremely hazardous operation at best.

Another operation that has been mentioned as a possible analogy is the mowing of the rights-of-way. Accidents do occasionally occur with mowing equipment but not as often as some may expect. Rarely does the equipment operate from the shoulder or interfere with traffic. If mower operators are properly trained, they use good operating procedures such as flashing lights, signs, and visible clothing and equipment; they operate, if at all possible, facing traffic. They mow away from the shoulder edge and cross traffic at opportune times. They must move onto the shoulder at guardrails and over bridges, but again they are supposed to carefully choose opportune times. Equipment is required to be parked well away from the roadway for breaks and overnight—out of the 30-ft clear zone is the usual requirement. Although mowing operations rarely interfere with traffic movement to cause delays or reduced capacity, accidents do occasionally occur. For instance, a piece of equipment may be struck while momentarily stopped on the shoulder or while trying to mow over a guardrail from the shoulder with special boom mowers in a difficult area.

Construction work on bridges where the shoulders, next to both the median and the outside edge, are closed for long periods of time is another possible analogy. These operations require the New Jersey temporary barrier (see Fig. D.6) next to the traffic lane, arrowboards, cones, and barrels to direct traffic by the obstacle. Even when these barriers are used next to or adjacent to the traffic lane but do not encroach on the lane, traffic movements are restricted somewhat and congestion and delays do occur during heavy flows. Traffic accidents are numerous in these areas, as can be observed from the barriers themselves. These stationary objects may be in place a year or more, at night and during adverse weather, which may account for many of the accidents. Although barriers are not a good example of an analogous activity, it illustrates that drivers respond differently and erratically to any unusual condition along the highway, particularly Interstate highways.

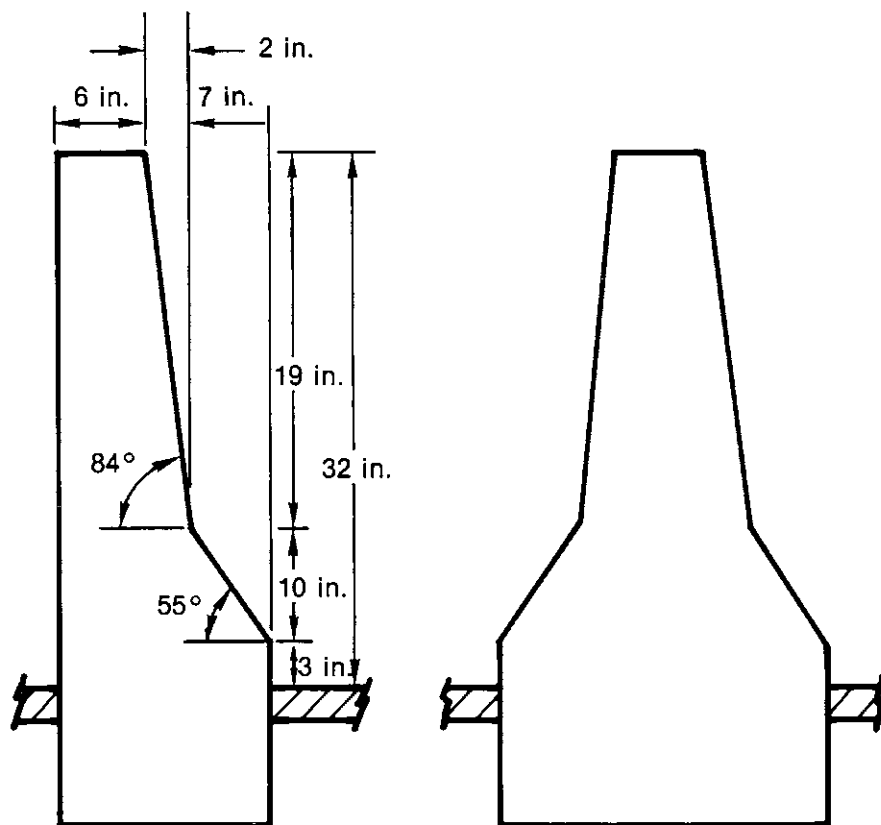


Fig. D.6—New Jersey concrete barrier

CONCLUSION

It appears that it is possible to install fiber-optics cable in Interstate highway rights-of-way without long periods of serious disruption to traffic. Few accidents, and those all minor, have been reported, indicating that on toll facilities—thruways and turnpikes—the cable can be installed underground without causing serious accidents and that such agencies as AT&T can be relied upon to provide safe work zones. This seems to be true for at least the early stages of the installations. The overall credibility of utility agencies regarding safety in work zones on highways is poor; perhaps now the fiber-optics group will attempt to overcome that image.

The median of a freeway is the least desirable location to install fiber-optics cable. It involves work next to the high-speed lanes and equipment must move across traffic to access the installation site. Work in the median may also result in a lane closure due to the proximity of the work to the moving traffic. Installation at the outside edge of the shoulder is the next least desirable location. Although work at the shoulder edge may be done without necessitating a lane closure, it is still close to moving traffic and interferences can be expected, resulting in congestion, reduced capacity during installation and maintenance, backups, delays, and accidents. Under no conditions should the pavement on an Interstate highway be cut, including the paved shoulders, for any such installation.

If fiber-optics installations are permitted on Interstate highway rights-of-way, the ideal location would be outside the access control fence which might be accomplished by moving the fence in to accommodate the utility. The next best place for such installations would be between the fence and the slope lines (top of cuts and toe of fills). Should the installations be permitted, exact cable locations should be predetermined before installation and strictly adhered to for both horizontal and vertical alignment. The cable locations should be well marked to prevent damage from highway maintenance and construction crews.

There are some conditions peculiar to the Interstate highway system to be aware of. It is fully user paid for, contrary to the beliefs of some. It has been free of access and encroachments of utility installations except for crossings and a few extreme isolated hardship cases, usually where construction of an Interstate highway forced a utility into hardship. Since the beginning, efforts have been continually exerted to improve safety on the system. The 30-ft clear zone, bridge widening, removal of (or protection at) fixed objects, breakaway sign posts and light standards, and attenuators at gore areas are some examples. Installations of utility facilities such as fiber-optics cable amount to a proliferation of activity on the Interstate system and will add to activities interfering with traffic flow. It is inevitable that the installation and maintenance of such facilities will, in some way, affect the safety and free movement of vehicles on the highway. Just how much proliferation of utility facilities on Interstate highway rights-of-way will occur if fiber optics are permitted there is unknown, but other facilities can present just as good a case for the right to install their facilities as fiber optics. They will be there.

It is suggested that if utilities are permitted on Interstate highway rights-of-way, traffic control should be conducted by the state DOT

involved at the cost of the utility. This probably should also be true for all freeway facilities including toll thruways and turnpikes.

Toll highways are constructed under the assumption that they will be paid for from toll collections and that fees will be raised to cover shortfalls. Since state DOTs and the FHWA usually do not have authority over these facilities, some operations may be considered and permitted that would not be considered by the FHWA and state DOTs. Toll booths alone are designed to bring vehicles to a stop, or virtually so, to prevent escape of toll fees. Authorities responsible for operating toll highways may welcome new ways of generating revenues. Toll highways, although classified as freeways, do not operate at the high level of the Interstate highway system. Although construction and maintenance operations on toll highways are generally conducted in a safe manner with due consideration for the traveling public, these activities are not always carried out with the same rigid requirements and dispatch applied to Interstate highways. Care should be used in comparing toll freeways and Interstate highways. The design, construction, and operating standards are not the same.

REFERENCES FOR APPENDIX D

- American Association of State Highway and Transportation Officials, *Highway Design and Operational Practices Related to Highway Safety*, First Edition, Washington, D.C., February 1967.
- American Association of State Highway and Transportation Officials, *Highway Design and Operational Practices Related to Highway Safety*, Second Edition, Washington, D.C., 1974.
- American Association of State Highway and Transportation Officials, *Utility-Related Highway Hazards*, International Right of Way Association Highway—Utility Liaison Committee, Final Report, Washington, D.C., June 1983.
- Byrd, Tallamy, MacDonald and Lewis Consulting Engineers, *A Supplement to a Guide for Selecting, Locating and Designing Traffic Barriers*, Falls Church, Virginia, April 1985.
- Collins, J. C., and J. L. Morris, *Highway Collision Analysis*, Charles C. Thomas Publishing, Springfield, Illinois, 1974.
- Copas, T. L., and H. A. Pennock, *Reducing Construction Conflicts Between Highways and Utilities*, Transportation Research Board, National Research Council, National Cooperative Highway Research Program, Synthesis of Highway Practice No. 115, Washington, D.C., December 1984.
- Council, F. M., and W. W. Hunter, *Implementation of Proven Technology in Making the Highway Environment Safe*, University of North Carolina Highway Safety Research Center, Chapel Hill, North Carolina, August 1975.
- Dart, O. K., Jr., and L. S. McKenzie, "A Study of Roadway Fatal Accidents in Louisiana With Proposed Enforcement and Engineering Countermeasures," article prepared for presentation at the 61st annual meeting of the Transportation Research Board, Baton Rouge, Louisiana, August 1981.
- Florida Department of Transportation, District Utility Engineers, Electric Utilities, Florida Power Group, *Joint Workshop Notebook and Materials*, Orange Springs, Florida, March 10–12, 1985.
- Highway Research Board (now known as Transportation Research Board), *Highway Capacity Manual*, Division of Engineering and Industrial Research, National Research Council, Special Report No. 87, Washington, D.C., 1965.
- Iddinns, J. M., and C. F. Scholer, *Pavement Cuts for Utilities: A Guide for Their Management*, Purdue University Highway Extension

- and Research for Indiana Counties and Cities, Publication No. H-84-6, West Lafayette, Indiana, October 1984.
- Iddinns, J. M., and C. F. Scholer, *Pavement Cuts for Utilities: A Field Guide to Their Accomplishment and Maintenance*, Purdue University Highway Extension and Research for Indiana Counties and Cities, Publication No. H-84-7, West Lafayette, Indiana, October 1984.
- Johnson, E. M., "Guidelines for Utility Locations," *Public Works*, April 1969.
- Jones, D. H., "Traffic Accidents, Traffic Delays, and Highway Capacity as Related to the Installations of Utility Facilities Within Highway Rights-of-Way," thesis presented to the Graduate Council of The University of Tennessee, Knoxville, March 1969.
- Koenig, R. A., Jr., *Encasement of Pipelines Through Highway Roadbeds*, Final Report 20-7/22, National Cooperative Highway Research Program Project No. 20-7, Byrd, Tallamy, MacDonald and Lewis Consulting Engineers, Falls Church, Virginia, March 1983.
- Koenig, R. A., Jr., *Longitudinal Occupancy of Freeways by Utilities*, Final Report 20-7/11, National Cooperative Highway Research Program Project No. 20-7, Byrd, Tallamy, MacDonald and Lewis Consulting Engineers, Falls Church, Virginia, July 1978.
- LaBelle, D. N., et al., *Reimbursable Relocation Study*, Florida Power and Light Company, Reimbursable Relocation Task Force, Project Report No. 3, April 1981.
- Transportation Research Board, *Roadside Hazards, Traffic Barriers, and Safety Appurtenances*, National Research Council, Special Report 769, Washington, D.C., 1980.
- Transportation Research Board, *Policies for Accommodation of Utilities on Highway Rights-of-Way*, National Research Council, National Cooperative Highway Research Program, Project No. 20-5, Report No. 34, Washington, D.C., 1976.
- Transportation Research Board, *Effectiveness of Clear Recovery Zones*, National Research Council, National Cooperative Highway Research Program, Report No. 247, Washington, D.C., May 1982.
- Transportation Research Board, *Development of Safer Highway Appurtenances and Utility Poles*, National Research Council, Transportation Research Record No. 942, Washington, D.C., 1983.
- Transportation Research Board, *Utility Facilities in Transportation Corridors*, National Research Council, Transportation Research Record No. 571, Washington, D.C., 1976.
- Transportation Research Board, *Highway Capacity Manual*, National Research Council, Special Report No. 209, Washington, D.C., 1985.

- Transportation Research Board, *Peak-Period Traffic Congestion Options for Current Programs*, National Research Council, National Cooperative Highway Research Program, Report No. 169, Washington, D.C., 1976.
- Transportation Research Board, *Analysis of Highway Accidents, Pedestrian Behavior, and Bicycle Program Implementation*, National Research Council Transportation Research Record No. 847, Washington, D.C., 1982.
- Transportation Research Board, *Evaluation of Traffic Controls for Highway Work Zones*, National Research Council, National Cooperative Highway Research Program, Report No. 236, Washington, D.C., October 1981.
- U.S. Department of Transportation, *Manual on Uniform Traffic Control Devices for Streets and Highways* (Rev. 4, March 1986), Federal Highway Administration, Office of Traffic Operations, National Advisory Committee on Uniform Traffic Control Devices, U.S. Government Printing Office, Washington, D.C., 1978.
- U.S. Department of Transportation, *Assessment of Techniques for Cost-Effectiveness of Highway Accident Countermeasures*, Federal Highway Administration, Office of Research and Development, Environmental Design and Control Division, Report No. FHWA-RD-79-52, Executive Summary, Final Report, Washington, D.C., January 1979.
- U.S. Department of Transportation, *Guide to Safety Features for Local Roads and Streets*, Federal Highway Administration, Washington, D.C., 1986.
- U.S. Department of Transportation, *Fatal Accident Reporting System 1984, A Review of Information on Fatal Traffic Accidents in the U.S. in 1984*, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, Washington, D.C., 1984.
- U.S. Department of Transportation, "Monthly Fatality Report – June 1986, Regional and National Traffic Fatality Estimates," *Highway Safety Facts*, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, Washington, D.C., 1986.
- U.S. Department of Transportation, *The Economic Cost to Society of Motor Vehicle Accidents*, National Highway Traffic Safety Administration, Washington, D.C., 1983.

Appendix E

EXEMPLARY TOLL ROAD AUTHORITY/ COMMUNICATION COMPANY AGREEMENT

GRANT OF NON-EXCLUSIVE EASEMENT

THE ILLINOIS STATE TOLL HIGHWAY AUTHORITY, an instrumentality and administrative agency of the State of Illinois, hereinafter sometimes referred to as "GRANTOR" for and in consideration of the promises, covenants and fees as hereinafter provided, does hereby grant to AT&T COMMUNICATIONS, INC., a Delaware Corporation, authorized to do business in the State of Illinois, with an office at 300 South Riverside Plaza, 2nd Floor, Chicago, Illinois 60606, hereinafter sometimes referred to as "GRANTEE", a NON-EXCLUSIVE EASEMENT, hereinafter sometimes referred to as "GRANT", to construct, install, operate, maintain, inspect, repair, replace and remove a lightguide cable, consisting of twenty-eight (28) mode fibers stranded around a fiber glass core. The cable shall be a waterproof or filled type requiring no air pressurization equipment, hereinafter sometimes referred to as "CABLE", for use in transmission of communications, but not radio frequency or any other type that will interfere with the transmission of communications by the GRANTOR in its present or its future operation of the Tollway, on East-West Tollway along the south side fence line for a distance of approximately 24.6 miles from 22nd Street, Oak Brook, Illinois westerly to the Route 56 Ramp, and for a distance of 5' on each side of the cable location, all as approved from time to time by the GRANTOR and as delineated on GRANTEE'S drawings, attached hereto as Exhibit "A" and made a part hereof, and located on the real estate owned or occupied by GRANTOR situated in Du Page County and Kane County, together with the right of ingress and egress upon the Easement Premises, for purposes of constructing, installing, operating, maintaining, inspecting, repairing, replacing and removing said CABLE according to plans, specifications, conditions, requirements and procedures approved by the Chief Engineer of the GRANTOR, hereinafter sometimes referred to as "Chief Engineer", from time to time as set forth hereinafter. Said Exhibit "A" shall consist of preliminary plans and specifications and will be substituted with "AS-BUILT" plans and specifications upon completion of the installation, and approved thereof by GRANTOR, of the CABLE. This GRANT is subject to conditions of record and GRANTOR makes no representation as to such conditions or representations or warranties as to GRANTOR's title or interest in the Easement Premises. By GRANTEE'S acceptance of this GRANT, by execution hereof, GRANTEE agrees to the terms and conditions of this GRANT, and in the event of any violation thereof in addition to the requirements, specifications, damages and responsibilities of GRANTEE hereof, all interest of the GRANTEE in this GRANT shall, at the option of the GRANTOR, revert to GRANTOR, its successors and assigns, and GRANTEE shall have no further interest in the Easement Premises. It is

- E.3 -

understood and agreed by GRANTOR and GRANTEE that this Grant of Non-exclusive Easement herein shall not extend to any paved portion of GRANTOR's property. Additional terms, conditions and limitations of said GRANT are as set forth in the following Articles commencing with ARTICLE I, ADDITIONAL TERMS OF GRANT, and terminating with ARTICLE IV.

ARTICLE I

ADDITIONAL TERMS OF GRANT

This NON-EXCLUSIVE GRANT OF EASEMENT is subject to the following terms, conditions and limitations:

SECTION 1. TERM

A. Term: The term of this GRANT shall commence as of the 18th day of June 1984 and shall continue for a period of twenty-three (23) years from said date, terminating on June 17, 2007, subject however, to early termination by the GRANTOR as provided in this GRANT or by operation by law.

B. Extensions: If GRANTEE shall have timely and properly performed all of GRANTEE'S duties and obligations as set forth in this GRANT, including but not limited to all payments and/or reimbursements due to the GRANTOR, GRANTEE shall have the option of negotiating an extension of this GRANT for an additional period of twenty-five (25) years ending June 17, 2032 according to the terms hereof, provided however, that the fees and expenses to be paid by the GRANTEE to the GRANTOR, shall be based on economic conditions, needs and requirements at such time and in the future, as determined by the sole discretion and judgment of the GRANTOR.

C. Additional Cables: Nothing herein is intended to permit GRANTEE to construct or install additional cables of any kind within the Easement Premises following the initial construction and installation of the CABLE.

SECTION 2. FEES AND EXPENSES:

A. Fees: The GRANTEE shall pay to GRANTOR as consideration for this NON-EXCLUSIVE GRANT OF EASEMENT, the sum of TWO HUNDRED FIFTY THOUSAND and 00/100 DOLLARS (\$250,000.00) on or before the date of the initial construction of the CABLE.

B. Expenses: GRANTEE shall also pay or reimburse GRANTOR for all salaries, fringe benefits, fees, costs and expenses incurred by GRANTOR, its officers, directors, staff, employees, attorneys, consultants and for outside agents retained by the

- E.4 -

GRANTOR during the preparation, review and approval process, and operations thereafter, in connection with this GRANT. Nothing herein is intended to limit GRANTEE'S obligations to be responsible for any and all taxes, assessments, claims, judgments, licenses, fees, costs and expenses incurred or assessed against GRANTOR during the entire term of this GRANT and GRANTEE shall promptly pay or reimburse GRANTOR for any such taxes, assessments, claims, judgments, licenses, fees, costs and expenses due to this GRANT and the actions or inactions of GRANTEE.

SECTION 3. GRANTOR'S RIGHTS

A. Reservation of Rights: GRANTOR, in addition to its rights to terminate this GRANT or to require relocation of the CABLE from the Easement Premises as hereinafter provided reserves unto itself and its grantee's, permittees, lessees and assignees at all times the right to use the area above, below, or adjacent to the CABLE and under, upon, through and across the Easement Premises for any and all Toll Highway purposes, including, but not limited to the grant of any other permit or easement which does not substantially interfere with GRANTEE'S operation of the CABLE.

B. Non-Interference: GRANTEE'S installation, maintenance, inspection, operation, repair, replacement, removal and other activities on and uses of the Easement Premises shall be subject to and shall not interfere with the safe and efficient operation of traffic, maintenance, construction, reconstruction of highway traffic or any other operation or activities of the GRANTOR on the East-West Tollway. In the event, in the reasonable judgment of GRANTOR's Chief Engineer, after consultation with GRANTEE, the safety or protection of Toll Highway patrons, personnel or property are adversely affected by GRANTEE'S planned or actual actions, inactions or uses of the Easement Premises, GRANTEE shall, without any cost or expense to GRANTOR, change its plans, halt any activities or take any actions as directed by the Chief Engineer that he, in his sole discretion determines necessary to protect the patrons, personnel or property of the GRANTOR.

C. Relocation: GRANTEE agrees that, in the event any of GRANTEE'S installation or operations interfere with any operation, reconstruction, improvement, widening or expansion of the Toll Highway System, GRANTEE shall, upon written notice from the Chief Engineer, and within such reasonable time or times as may be established by GRANTOR, from time to time, and at GRANTEE'S sole expense, relocate, alter, or protect the CABLE as directed by the Chief Engineer so as to avoid interference with such operation, reconstruction, improvement or widening. If any area within the Easement Premises, or other unpaved

- E.5 -

portions of GRANTOR'S property or property hereafter acquired by GRANTOR in connection with the aforesaid operation, reconstruction, improvement, or widening of the Toll Highway System is available, GRANTOR shall permit the relocation of the CABLE to such area that would not interfere with GRANTOR'S operations pursuant to the terms and conditions of the GRANT. Such relocation or alteration shall be located on property not owned by the GRANTOR only if suitable locations within GRANTOR'S property or property hereafter acquired by GRANTOR which do not interfere with GRANTOR'S plans or operations are not available. Nothing herein shall require GRANTOR to acquire property for the purpose of relocation of the CABLE. All costs, fees, and expenses of any such relocation or alteration of the CABLE shall be at the expense of GRANTEE. If GRANTOR is required by the presence of the CABLE to alter its plans for future improvements or operations to avoid interference with the CABLE, then GRANTEE shall pay all costs, fees, and expenses due to such alteration. Nothing herein shall require GRANTOR to alter or vary its existing or future construction plans and methods to avoid interference with the CABLE and related GRANTEE facilities, and GRANTOR reserves for itself sole and complete discretion regarding future design, operation, maintenance, alteration, construction, and reconstruction of the Illinois Tollway System.

D. Designation of Responsibility: Not less than thirty (30) days prior to commencement of installation on the Easement Premises, the GRANTEE shall appoint a Project Engineer who shall be directly in charge of the work to be performed pursuant to this GRANT and who shall be the liaison with the GRANTOR'S Chief Engineer or his representative. GRANTEE'S Project Engineer shall be assigned to the project on a full time basis, be familiar with the plans and specifications of all contracts awarded by the GRANTEE, and shall be in charge of GRANTEE'S employees, agents, and contractors assigned to perform work under this GRANT. The Project Engineer shall be accessible to and cooperate with the Chief Engineer or his representative. The GRANTEE shall provide GRANTOR in writing with a list of all personnel in charge of work on the project and keep said list current. GRANTEE shall immediately notify GRANTOR in the event of change in the Project Engineer. The GRANTEE shall submit to GRANTOR a listing of authorized persons to be contacted in the event of an emergency. Within ten (10) days prior to commencement of construction activities on the Easement Premises, the Chief Engineer shall notify GRANTEE of and designate in writing the persons who shall serve as his representatives throughout the design, construction, inspection, and maintenance activities. One of the Chief Engineer's representatives shall be designated as the liaison for the

- E.6 -

GRANTOR in connection with the GRANTEE'S day to day activities and shall be the person with whom GRANTEE shall be required to communicate whenever GRANTEE is required by this GRANT to communicate with or seek approval from the Chief Engineer. Any action required to be in writing must be signed by the Chief Engineer. The Chief Engineer shall have the right to change his representatives upon notice in writing to GRANTEE.

E. Plats and Legal Descriptions: GRANTEE agrees that in the event that a legal description of any or all of the parcels of property defined as the Easement Premises is determined by GRANTOR'S Chief Engineer to be needed at any time by GRANTOR for any purpose, GRANTEE shall promptly prepare or cause to be prepared such surveys, parcels plats, and legal descriptions including (metes and bounds, if required), plats of survey or any other property related documents, as determined at the sole discretion of GRANTOR, and such documents shall be sealed by an Illinois Registered Land Surveyor, all the aforementioned to be performed and provided at the sole cost and expense of GRANTEE, and in accord with reasonable standards and criteria established by GRANTOR and said legal description shall become Exhibit "B" hereof as if fully set forth herein at the time of the execution of this GRANT.

SECTION 4. CROSSING PERMITS.

GRANTEE shall, in connection with any crossings of paved portions of the Toll Highway System that are expressly referred to on plans and specifications approved by the Chief Engineer, apply for, comply with, and be subject to procedures established for the granting of permits by GRANTOR generally for crossings under paved portions of the Toll Highway System. In addition to the provisions hereof, GRANTEE shall additionally be compelled to comply with each and every requirement of GRANTOR, as established from time to time for the granting of permit crossings except that no fees, permit bonds, or insurance separate from those otherwise required of GRANTEE herein therefor, shall be assessed or requested by GRANTOR for permit crossings approved prior to, during or in connection with the initial installation of the CABLE. GRANTEE shall have no easement interest or rights for and in connection with crossings, except for those arising pursuant to GRANTOR'S permit procedures as GRANTOR shall from time to time establish generally for such permit crossings. Nothing is intended to imply, nor shall it give GRANTEE the right to additional crossings, or permits therefor, not set forth in the approved plans and specifications for the initial installation of the CABLE herein. Any such other permits or crossings shall be subject

- E.7 -

to approval of the GRANTOR and such approval shall be within the sole discretion of the GRANTOR.

ARTICLE II

INITIAL DESIGN AND CONSTRUCTION REQUIREMENTS

SECTION 1. PRECONSTRUCTION PROCEDURES

A. Plans and Specifications: GRANTEE shall be responsible for the preparation of all plans and specifications for work to be performed on the Easement Premises and such plans and specifications shall be submitted to GRANTOR, for approval by GRANTOR, prior to commencement of such work which approval shall not be unreasonably withheld or delayed. The plans and specifications for each construction contract shall incorporate those features and provisions identified for inclusion in the respective construction section and/or required by this GRANT. In the event GRANTOR disapproves of said plans and specifications, GRANTOR shall cause its Chief Engineer to indicate in writing, specific objections and GRANTEE shall thereafter correct and resubmit such revised plans and specifications in accord with GRANTOR'S requirements. GRANTEE shall promptly provide, from time to time, GRANTOR with any and all information and documents that GRANTOR may reasonably require to evaluate and review GRANTEE'S plans and specifications. Any changes later proposed to approved plans or specifications affecting the Easement Premises, GRANTOR'S property, or the CABLE shall be resubmitted to GRANTOR for prior approval in accord with this section prior to commencement of any work thereon.

B. Preconstruction Meeting: GRANTOR'S Chief Engineer shall be given prior written notice of and invited to any preconstruction meetings between GRANTEE'S Project Engineer and GRANTEE'S contractors employed to perform work on GRANTOR'S property or the Easement Premises.

C. Changes, Alterations or Improvements of Plans: Notwithstanding GRANTOR'S initial approval of the plans and specifications for the CABLE, should changes, alterations, or improvements in the approved plans and specifications become necessary or desirable in connection with the operations of the Illinois Tollway System, as reasonably determined by GRANTOR, GRANTEE shall promptly prepare and perform such design construction, reconstruction, relocation, or alteration as may be required to implement the changes decided by the GRANTOR, at no cost or expense to GRANTOR.

D. Pre-existing Permits and Utilities: GRANTEE shall be responsible for examining the Easement Premises and all documents and plans relating thereto whether in the possession of

- E.8 -

GRANTOR or others, and for identifying any and all obstructions, utilities, drainage facilities, interests, pipes, lines, and the like within the Easement Premises, whether above or below ground, and GRANTEE shall be responsible for any and all damages, interferences, effects, relocations, costs, improvements and charges of every kind and nature that may arise therefrom. GRANTEE shall further be required to give prior written notice to each and every individual or entity having facilities on or an interest in the Easement Premises of Grantee's planned installation of the CABLE. GRANTEE shall, prior to commencing construction, make provision for the protection, accommodation, and/or relocation of said facilities and interests. All such arrangements shall be at the sole cost and effort of GRANTEE. Copies of any agreements relating thereto shall be provided to the Chief Engineer prior to commencing installation at the locations covered by said agreements. Any agreement or work involving relocation of such facilities shall be subject to approval of the Chief Engineer. However, the GRANTOR shall not impose nor require any standards greater than those required by the present policy of GRANTOR relative to utility installations. It is understood and agreed that GRANTOR shall be under no responsibility to GRANTEE to grant, cause, or arrange for such agreements or relocations.

E. Plan Review by Chief Engineer: Except for previously approved Crossing Permits as defined in ARTICLE I, SECTION 4, prior to advertising for letting of any construction contract involving the GRANTOR or GRANTOR'S property, the GRANTEE shall submit to the Chief Engineer for review and approval, contract documents for the proposed construction. Following review of said documents, the Chief Engineer will notify the GRANTEE within thirty (30) days after receipt thereof in writing of approval of the plans and specifications or state its objections, including reasons for the disapproval thereof. No construction shall begin on the GRANTOR'S property prior to said approval by the Chief Engineer. During construction, GRANTEE shall require its contractor to submit shop drawings for construction of all major items of work on the Easement Premises or on GRANTOR'S property. GRANTEE shall forward (one) 1 copy of all shop drawings to the Chief Engineer for approval prior to construction of the specified work item. Shop drawings are required for, but not limited to, augering and jacking operations, installation, shoring and appurtenant facilities.

F. Progress Schedules: GRANTEE shall submit to GRANTOR a Progress Schedule showing the dates projected for starting and completing various design, construction and maintenance activities for the entire CABLE within GRANTOR'S property. The submission shall clearly indicate the types of work to be in progress and show that throughout each stage of the work, reasonable time periods are allowed in order to assure that the work

will be completed within the stated duration. The schedule shall indicate the established construction limits of each segment of the CABLE, all contract awards and completion of contracts in all segments of the Easement Premises. GRANTEE shall report to the Chief Engineer or representative at the end of each month to inform him of the progress to date and any alterations in the approved schedule. The Progress Schedule shall be kept current during the design and construction process and updated periodically when changes occur and shall be submitted to the GRANTOR for approval of the Chief Engineer with an explanation of any revisions since the previous submittal.

SECTION 2. SPECIAL CONTRACT REQUIREMENTS

A. Contractors and Subcontractors: GRANTEE shall require in all contracts for installation of the CABLE or related work affecting the Easement Premises or affecting any other GRANTOR property that contractors or subcontractors rights and obligations pursuant to their contracts with GRANTEE include, but not be limited to, the terms and conditions of this GRANT and the following requirements:

(1) Hold Harmless: GRANTEE shall include a clause similar in content to ARTICLE IV, SECTION 3, whereby the contractor holds harmless and indemnifies GRANTOR, its officers, directors, employees, agents, and consulting engineers.

(2) Illinois Fair Employment Practices Commission: GRANTEE shall require the contractor to adopt all of the applicable requirements, provisions, and rules and regulations of the Illinois Fair Employment Practices Act, as amended, (Ill. Rev. Stats., Ch. 48, Sec. 851 et seq.) and all of the applicable rules and regulations promulgated thereunder by the Illinois Fair Employment Practices Commission.

(3) Payment and Performance Bonds: The GRANTEE shall require from each construction contractor Payment and Performance Bonds in form approved by GRANTOR in the full amount of each construction contract from each contractor involved, and said Bonds shall name GRANTOR as an additional obligee.

(4) Insurance: GRANTEE shall provide to the GRANTOR, certificates of insurance from each construction contractor or from GRANTEE naming GRANTOR as an additional insured party. Certificates of insurance shall be on Insurance Service Organizations (ISO) Form and provide thirty (30) day notice of cancellation. The certificates shall be signed by the insurance companies or their authorized agents. The insurance companies must be authorized to do business in the State of Illinois.

- E.10 -

(5) Continuous Coverage: GRANTEE shall require the contractor to maintain in full force the coverages required in this section for the term of the contract. The GRANTEE shall not allow any subcontractor to commence work on any portion in connection with the installation of the CABLE without evidence that the subcontractor has insurance coverage equal to the coverages required in this section.

(6) Coverage Requirements: Certificates of insurance from any contractor performing work for the GRANTEE on the Easement Premises shall show the following minimum amounts of insurance coverage to be in effect:

- (a) Comprehensive Automobile Liability:
 \$ 500,000 Bodily Injury per person
 1,000,000 Bodily Injury per occurrence
 500,000 Property Damage per occurrence
- (b) Worker's Compensation and Employer's Liability Insurance: covering the obligations of the company in accordance with the provisions of the Worker's Compensation Law of the State of Illinois.
- (c) Comprehensive General Liability: Policy shall include coverage for Premises and Operations, Contractor's Protective Liability, Completed Operations, Broad Form Blanket Contractual Liability, Broad Form Property Damage, including Completed Operations and Personal Injury Liability. Where the hazard exists, the coverage shall protect against claims of explosive, collapse, or underground damage.
 \$1,000,000 Bodily Injury per person
 1,000,000 Bodily Injury aggregate limit
 500,000 Property Damage per occurrence
 1,000,000 Property Damage aggregate limit
- (d) Umbrella Coverage: In addition to the limits of coverage specified above, an Umbrella or Excess Liability Policy of not less than \$2,000,000 for any one occurrence and subject to the same aggregate over the Comprehensive Automobile Liability, Employer's Liability, and Comprehensive General Liability coverages is required. Umbrella coverage is subject to approval of the GRANTOR as to form and amount of self-insured retention.
- (e) Owner's Protective Insurance:
 \$1,000,000 Bodily Injury per person
 1,000,000 Bodily Injury per occurrence

- E.11 -

\$500,000 Property Damage per occurrence
and aggregate limit.

Owner's Protective Insurance shall be purchased and maintained by the contractor and shall name the GRANTOR and its consulting engineers, Envirodyne Engineers, Inc. as named insureds.

B. Notice to Proceed: A written notice to proceed from the Chief Engineer will be required prior to commencement of construction of each phase of the installation of the CABLE on the Easement Premises or GRANTOR'S property. The Chief Engineer shall not be required to issue the Notice to Proceed for construction until GRANTEE shall have provided to GRANTOR final plans and specifications, Payment and Performance Bonds, and insurance certificates. The Chief Engineer shall not unreasonably withhold the issuance of the Notice to Proceed.

SECTION 3. CONSTRUCTION ACTIVITIES

A. Standard Specifications: All construction activities to be performed under this GRANT on the Easement Premises shall meet requirements of the Standard Specifications for the Northern Illinois Toll Highway January 1, 1982, and supplement dated June 1, 1983, except as approved otherwise by GRANTOR, and except as otherwise set forth in this GRANT.

B. Maintenance of Tollway Traffic: GRANTEE agrees that all construction and maintenance work that is to be performed on the Easement Premises shall be performed so as not to conflict with or affect the normal operation of Toll Highway traffic.

- (1) Traffic Control: Traffic control required due to GRANTEE's construction or other GRANTEE activities on the Easement Premises shall be conducted according to standards established by, and subject to prior approval by the Chief Engineer. GRANTOR shall, at all times, have the right to employ its own forces or enter into its own contracts for such traffic control as may, in the sole but reasonable discretion of the Chief Engineer, be required for the safe and efficient flow of Tollway traffic.
- (2) Expenses: Costs of traffic control required by this subsection shall be the responsibility of GRANTEE, and GRANTOR shall be promptly reimbursed therefor by GRANTEE. If feasible, prior to incurring any costs for traffic control hereunder, GRANTOR shall give GRANTEE a written estimate of such costs and shall send GRANTEE an itemized bill

- E.12 -

for such costs quarterly. These costs will be separate from the fee described in ARTICLE 1, SECTION 2. A. of this GRANT and will include, but are not limited to the installation, maintenance, and removal of signs, cones, barriers, lane dividers and barricades as well as the use of flagmen.

- (3) Specific Requirements: Each construction contract for work adjacent to Tollway traffic shall include the following traffic control provisions:

- (a) Concrete barrier wall, guardrail, or other positive approved protective devices shall be placed at sites in which work activities are conducted within the clear zone width in accordance with American Association of State Highway and Transportation officials (AASHTO) criteria.
- (b) Any advance construction signing shall be removed from view of the motorist after work hours.
- (c) No work will be permitted on the Easement Premises from 12:00 (Noon) of the day preceding a national holiday until after 12:00 (Noon) of the day following a national holiday or on the Friday and Monday before and after a holiday weekend.

C. Access to Construction Site: It is understood and agreed between the parties hereto that GRANTEE shall perform all installation, construction, replacement, restoration, alteration, improvement, reconstruction, and/or repair or maintenance work without access to or from the travel lanes of the Toll Highway System or ramps or shoulder adjacent thereto from or to the Easement Premises or from or to GRANTOR'S property. GRANTOR shall have the absolute right to deny all ingress to and egress from the Easement Premises from and to the GRANTOR'S travel lanes, ramps, and shoulders. Subject to said rights of GRANTOR, GRANTEE may, from time to time, request of the Chief Engineer special permits or approvals for such access to vehicles hauling materials and equipment to and from the construction site. Under no circumstances will personal vehicles be permitted access to the GRANTEE'S construction sites or to be parked on the Easement Premises.

D. Storage of Vehicles and Equipment: Vehicles and equipment shall not be allowed at the construction sites on GRANTOR'S property, except as specifically required for current construction operations. If GRANTEE'S construction activities

- E.13 -

require the storage of equipment or materials, the storage sites must be at locations designated by and with prior approval of the Chief Engineer.

E. Progress Reports: Not less than every three (3) months commencing with date of initial installation, the GRANTEE shall obtain from each construction contractor and provide the Chief Engineer with reports describing the progress of all contracts and all major items of work and include updated estimates for commencement and completion of all major items and phases of the work. In the event that the GRANTEE'S scheduled work activities are materially affected by changes in the plans or the amount of work required due to circumstances unknown at the time GRANTEE and its contractor initiated work, GRANTEE shall submit a revised Progress Schedule as required in ARTICLE II, SECTION 1. F. to describe the items of work remaining and the schedule that is proposed to prosecute the balance of the work. GRANTEE shall use all practicable means to make the progress of work conform to that shown on the approved Progress Schedule. If GRANTEE falls behind the scheduled progress, then necessary steps must be taken to improve the progress. In the event that the GRANTEE fails to do so, GRANTOR may, at the discretion of the Chief Engineer, require that GRANTEE implement measures such as additional equipment and manpower at no cost to GRANTOR.

F. Methods of Installation: All underground installation methods shall have the prior written approval of the Chief Engineer. Installations made through embankments or in cut section may be made by the trenching method. Where trenching is permitted, the CABLE shall be laid in accordance with approved methods, and the excavation backfilled and compacted immediately. Open excavation remaining overnight shall not exceed one hundred feet in length. Backfill material shall be placed in accordance with GRANTEE'S approved plans and specifications. In no event shall the travelled way or paved shoulders be disturbed during the installation.

G. Settlement: The GRANTEE shall use sheeting and bracing to support the walls of the trench where adjacent to Tollway pavements and all other areas where soil and sub-surface conditions so require in order to avoid damage to slopes, pavement, and shoulder. GRANTOR requires that GRANTEE establish pavement and shoulder profiles through the use of an acceptable surveying method at specific spacing and time intervals in locations of pipe jacking and tunneling or as otherwise specified by the Chief Engineer. Trench settlement and other deficiencies related to the construction procedures are the sole responsibility of the GRANTEE and shall be resolved in a manner and schedule approved by the Chief Engineer.

- E.14 -

H. Replacement of Landscaping: Should the trimming of trees, destruction or removal of trees, shrubs, or other landscaping within GRANTOR'S property be found necessary during the installation of the CABLE and related facilities, or in the servicing of facilities following construction, the GRANTEE must obtain prior written authorization for the work to be completed in accordance with the conditions prescribed by the GRANTOR. The GRANTEE shall be required to replace in kind sod and shrubbery and make reasonable replacement of trees or other landscaping features subject to the reasonable approval of the Chief Engineer. GRANTOR may plant other trees and shrubbery or other landscaping on the Easement Premises following installation that does not interfere with property installed.

I. Drainage: In areas where drainage facilities are affected during the construction operation, GRANTEE shall be responsible for maintaining adequate drainage to insure against ponding, flooding, and siltation. Ditches and culverts must not be blocked by excavated materials, and must allow uninterrupted flow in all drainage facilities during construction. Debris in ditches resulting from the construction activities of GRANTEE shall be immediately removed, and the ditch configuration, as previously determined or as defined by the extension of the adjacent slopes shall be reestablished. Drainage facilities, as well as sodding, seeding, and other landscaping improvements thereon, shall be restored as specified by the GRANTOR.

J. Fence Replacement and Temporary Fence Installation: When construction activities or access to the construction site require temporary removal of the existing fence, GRANTEE shall provide that the fence be dismantled, and removed from the construction site or used as temporary fence during the work activities. Fence removal shall only be performed after the GRANTEE has installed temporary fence thereby closing any openings to be made in the right-of-way fence line. Upon completion of GRANTEE'S construction activities, all areas of removed or damaged fence shall be replaced in kind with new fence in accordance with the Standard Specifications of the Northern Illinois Toll Highway January 1, 1982 and Supplement dated June 1, 1983.

K. Disposal of Excess Materials: GRANTOR has the right to selectively obtain and use all discarded materials at specified disposal sites on GRANTOR'S property which have been previously arranged by the GRANTOR and GRANTEE. GRANTEE shall give GRANTOR reasonable notice of the availability of such excess materials. All other discarded material, equipment, or supplies from GRANTEE'S operations shall be removed from GRANTOR'S property and disposed of outside of GRANTOR'S property by the GRANTOR at GRANTEE'S expense. If an authorized

- E.15 -

disposal is made on GRANTOR's property, it shall be done in the location and manner so designated by the Chief Engineer.

L. Coordination with GRANTOR Construction Activities:

GRANTOR reserves the right to perform work on its own behalf, and others, within GRANTOR'S property including the Easement Premises, and to permit public utility companies, contractors, and others to do work during installation of the CABLE within the limits of or adjacent to activities of GRANTEE. GRANTEE and its contractors shall cooperate to the fullest extent with GRANTOR and its contractors. The Chief Engineer and its contractor shall be notified in writing by GRANTEE at least ten (10) days prior to the start of any operation requiring co-operation with others. In the event GRANTEE'S construction or installation activities shall interfere with the GRANTOR'S planned work or the planned activities of the GRANTOR'S contractors or other authorized parties in the judgment of the Chief Engineer, GRANTEE shall adjust its activities, operations or work to avoid interference with said GRANTOR planned work.

M. Inspection of Construction Activities: GRANTEE is responsible for the work involved in the installation of the CABLE, including the quality control of all work performed. GRANTEE shall assign a Project Engineer to be on site at all times during performance of the work to assure that the activities and improvements are in conformance with the approved plans and this GRANT. GRANTOR and its consulting engineers will have the right, but not the responsibility, to inspect all GRANTEE'S construction activities. The Chief Engineer, or his representative shall have the right, but not the responsibility, to direct the Project Engineer to halt further activities if the GRANTEE or its contractor are not in compliance with approved plans or this GRANT, or if the work or activities of GRANTEE, in the judgment of the Chief Engineer, otherwise jeopardizes the safety of Tollway patrons or property. In such case, the said Project Engineer shall immediately halt the work.

N. Extra Work Orders Required Due to Tollway Inspections and Standards: If within the course of construction activities, the Chief Engineer finds that the GRANTEE or its contractors are not in conformance with this GRANT or with GRANTEE'S approved plans and specifications or that changes are required for the protection of Tollway property or patrons, or are necessary to avoid interference with Tollway maintenance or construction activities or operation. GRANTEE shall be responsible for any Extra Work Orders or Change Orders or other costs or expenses that may result and must assure that the extra work is to the satisfaction of the Chief Engineer.

O. Identification of Line in Place: GRANTEE shall identify the CABLE and its location on markers as designated by the

- E.16 -

Chief Engineer. Markers shall be attached to the right-of-way fence placed at grade or on marker post in a manner approved by the Chief Engineer.

P. Repair of Damage: In the event of damage to the property of GRANTOR or to GRANTOR'S facilities as a result of use of the Easement Premises or GRANTOR'S property by GRANTEE, its agents and assigns, or as a result of installation of CABLE by GRANTEE, its employees, guests, or agents on the Easement Premises, GRANTEE shall within any reasonable time established by the GRANTOR, and in accord with GRANTOR'S written demand, repair, replace, or restore said property to the same condition that existed prior to such damage in accord with plans and specifications approved by the GRANTOR. All such repairs or restoration shall be performed according to GRANTOR'S requirements and standards. If GRANTEE fails to so repair, replace, or restore or to diligently pursue efforts to do so within thirty (30) days from receipt of said written demand, then GRANTOR shall have the option of performing said repairs, replacements, or restoration with its own forces or by retaining its own contractors, and GRANTEE shall promptly pay for, or reimburse GRANTOR for all costs, fees, expenses, both direct and indirect incurred by GRANTOR in connection with said damage. In the event such work must be performed within less than thirty (30) days to protect the safe and proper operations of GRANTOR, said work shall be performed by GRANTOR or GRANTEE, as the case may be, in such lesser time as reasonably established under the circumstances by the Chief Engineer.

Q. Restoration: Following completion of each segment of GRANTEE'S installation of the CABLE upon or affecting the Easement Premises or GRANTOR'S property, GRANTEE shall promptly return the Easement Premises to the condition which existed thereupon prior to the commencement of such construction by GRANTEE, all according to plans and specifications, requirements and procedures, approved, from time to time, by the Chief Engineer. All ~~contracts for~~ the installation of the CABLE or the maintenance, inspection, repair, replacement and removal of the CABLE relating to the Easement Premises and GRANTOR'S property shall require that the Easement Premises and GRANTOR'S property be restored to the condition that existed thereupon prior to such construction promptly following the completion of installation activities in each work area. Within ten (10) days of GRANTEE'S written notice to GRANTOR of completion of restoration in a major work area, the Chief Engineer or his representatives may make an inspection of such work area, and if it does not approve the restoration work, GRANTOR will thereafter detail its objections in writing to GRANTEE, and GRANTEE shall correct same as required by this GRANT.

SECTION 4. COMPLETION OF CONSTRUCTION

A. Completion Deadline: Initial construction and installation of the CABLE shall be completed not later than one (1) year from the date of commencement of construction. GRANTEE shall, once construction is commenced, vigorously and continuously pursue a schedule of construction and restoration designed to complete all work within the shortest possible construction period that is less than one (1) year in duration. All sections of GRANTOR'S property shall be restored according to the approved plans and specifications as soon as possible. However, GRANTEE shall not be liable or responsible for any delays due to GRANTOR's actions contrary to this GRANT, strikes, acts of God, or war and in the event of such delay the time period for completion of initial construction and installation of the CABLE shall be extended for the amount of time GRANTEE is delayed by such causes. Commencement of construction of and installation of the CABLE on the Easement Premises shall begin no later than June 30, 1984.

B. Joint Final Inspection: A joint final inspection of the completed work shall be conducted by the representatives of the GRANTOR and GRANTEE. If GRANTOR shall have any objection to final payment based on the final inspection, GRANTOR shall be required to issue specific objections thereto within ten (10) days following said inspection for each segment of the work. If GRANTOR shall have no objections following the final inspection of completed work by GRANTEE, or upon correction of its objections by GRANTEE, GRANTOR shall indicate, in writing, within ten (10) days of such inspection or correction, that it has no objection to the issuance of final payment to GRANTEE'S contractor or contractors.

C. Final Payment to GRANTEE'S Contractors:

(1) Retainage: GRANTEE shall require retainage of not less than two per cent (2%) of the contract amount for any construction segment in connection with the construction and installation of the CABLE on the Easement Premises which may be due not earlier than the time of final payment.

(2) Prerequisites: GRANTEE agrees that prior to and in connection with making final payment to any contractor, engineer or other person performing work on the Easement Premises or GRANTOR'S property that GRANTEE shall require of said party the following:

- a. Waivers against GRANTOR: A fully executed release and waiver of rights, privileges, claims against, or for liabilities of GRANTOR, its officers, directors, agents,

- E.18 -

employees or consulting engineers relating to the contract or work performed, and relieving GRANTOR, its officers, directors, agents, employees and consulting engineers from all claims or liabilities for anything done or for any act or neglect on their part.

- b. Lien Waivers: GRANTEE shall obtain waivers of lien, executed and in proper form, for all work performed and materials supplied and promptly furnish GRANTOR with certified copies of such waivers.

D. Record Plans: GRANTEE shall provide "Record Plans" drawings and plans locating and showing all GRANTEE'S improvements and any other improvements relocated by GRANTEE from or within the Easement Premises and for permit crossings to GRANTOR promptly following completion of construction. The form and substance of said "Record Plans" drawings shall be subject to the reasonable approval of the Chief Engineer.

E. GRANTEE'S Responsibility: GRANTEE shall at all times be responsible for its work and the work of its officers, employees, agents, engineers, contractors, or subcontractors and its and their actions and inactions. The presence of GRANTOR'S representatives and the inspection or approval by the GRANTOR of the work, or the activities of the GRANTEE shall not relieve GRANTEE, its officer, employees, agents, engineers, contractors, or sub-contractors of and from their complete and full responsibility for the work and activities and the operation and use of the CABLE and for the performance of and compliance with all duties and obligations of GRANTEE pursuant to this GRANT or the law.

ARTICLE III

MAINTENANCE

1. SECTION 1. ROUTINE MAINTENANCE

A. Description: GRANTEE shall be responsible for and shall perform such routine maintenance on a periodic basis as required by recognized industry standards for lightguide cables.

B. Maintenance Procedures: Routine maintenance shall be performed in such a manner as to avoid interference with or disturbance to Tollway traffic. The Tollway pavement, shoulder or Easement Premises shall not be used for access to or egress without prior approval of the Chief Engineer. It is understood

that in performance of inspections or routine maintenance by GRANTEE, no unusual activities will be allowed which in the sole discretion of GRANTOR could create a hazard or distraction to Tollway patrons. GRANTEE may inspect or perform necessary action to identify locations of the CABLE for any other required work activity of the GRANTEE, subject to prior approval of GRANTOR.

C. Annual Inspection: GRANTEE shall be required to make or have made an inspection of the CABLE at least once each year and submit the findings to the Chief Engineer not later than thirty (30) days following the beginning of each new fiscal year. The report of the inspection shall include a list of all items inspected, the condition of those items and highlight all defects and deficiencies appearing in the CABLE. The report shall also include a summary of all anticipated maintenance, repair, or reconstruction work necessary for the proper operation of the CABLE for the ensuing reporting period based on the results of the GRANTEE's inspection. The method, frequency, and integrity of the inspection procedure and subsequent reports shall be subject to revisions from time to time as reasonably directed by the Chief Engineer. Determination of the condition of CABLE shall be accomplished by visible on-site inspection of the Easement Premises. No vehicle shall be allowed to travel the CABLE, Easement Premises or any other part of GRANTOR'S property for inspection and observation purposes by GRANTEE.

SECTION 2. MAJOR MAINTENANCE

A. Description: GRANTEE shall be responsible for and shall perform all major maintenance activities as identified through review of the annual inspection reports, as delineated in ARTICLE III, SECTION 1. C., as determined by the GRANTEE or GRANTOR at any other inspection or for the replacement of major components and equipment necessary for the CABLE and its service.

B. Requirements: GRANTEE and its contractors shall comply with the provisions of ARTICLE II for major maintenance activities. GRANTEE shall not commence major maintenance work activities prior to the issuance of a Notice to Proceed by the Chief Engineer. Prior to the Notice to Proceed, GRANTEE shall submit plans and specifications, construction contracts, Payment and Performance Bonds, insurance certificates and a Progress Schedule to the Chief Engineer. The GRANTEE'S submittals shall be in accordance with ARTICLE II, SECTIONS 1. and 2 and shall meet the requirements of the Standard Specifications for the Northern Illinois Toll Highway, January 1, 1982

- E.20 -

and Supplement dated June 1, 1983, and any other special reasonable requirements of the GRANTOR.

SECTION 3. EMERGENCY REPAIRS:

Notwithstanding any other provision in this GRANT, in the event emergency repairs of the CABLE or components are required, verbal authorization and Notice to Proceed followed by written approval of the Notice to Proceed from the Chief Engineer or his representative shall be allowed and be considered sufficient hereunder, which approval or Notice to Proceed shall not be unreasonably withheld or delayed. Upon resolution of each and every emergency situation, GRANTEE shall provide written description of the repair procedures and report on the causes of the emergency and the methods used to ameliorate the situation to the Chief Engineer within ten (10) days of the emergency repair procedure. In the event the required emergency repairs extend for a period exceeding one (1) day and/or should an outside contractor be retained to perform the repair work, all of the provisions of ARTICLE II shall apply

ARTICLE IV

GENERAL TERMS

SECTION 1. GOVERNMENTAL PERMITS AND COMPLIANCE WITH LAW

Whenever required, GRANTEE shall furnish GRANTOR with satisfactory proof of compliance with Federal, State, and local laws, statutes, ordinances, rules, regulations, orders, and decrees. GRANTEE agrees that it will timely obtain, at its sole expense, all necessary permits from Federal, State, Municipal and other public authorities for the construction, installation, operation, maintenance, inspection, repair, replacement, and removal of the CABLE and shall require its contractors, engineers, and agents to construct, operate, and maintain the CABLE in accordance with all applicable orders, rules, and regulations of any public authorities having jurisdiction over the same, including, without limitation, the Authority Act, Worker's Compensation Laws, the Fair Employment Practices Act, minimum salary and wage statutes and regulations, the Occupational Safety and Health Act, laws with respect to permits, licenses and fees in connection therewith, laws regarding maximum working hours, and laws and regulations with respect to use of explosives, to the extent any such laws and regulations apply to GRANTEE and/or its agents. However, the granting of this non-exclusive Easement and GRANTEE'S obtaining of permits from other governmental entities shall not be deemed a waiver of GRANTOR'S sole and exclusive rights, jurisdiction, and control over its property. Whenever rules,

- E.21 -

regulations, ordinances, laws and statutes of other governmental entities shall be inconsistent with plans approved by GRANTOR, GRANTEE shall comply with GRANTOR'S duly enacted, legal and valid resolutions, rules, regulations, and statutes but only if such do not require GRANTEE or its agents to commit a criminal offense. Further, GRANTEE'S obtaining of a permit from another governmental entity shall not relieve GRANTEE of and from GRANTEE'S obligation to comply with the requirements of this Section and the balance of this Easement Agreement.

SECTION 2. NO DISCRIMINATION

In the hiring of employees for the performance of work on the Easement Premises, GRANTEE and its contractors and subcontractors shall not, by reason of religion, sex, age, education, race, nationality, creed, color, union or non-union membership, discriminate against any citizen of the United States, in the employment of labor or workers, who are qualified and available to perform work to which the employment relates. Neither shall GRANTEE or its contractors, subcontractors, or any person on behalf of either, discriminate against or intimidate any employee hired for the performance of work under any such contract, on account of religion, sex, age, education, race, nationality, creed, color, union or non-union membership.

SECTION 3. HOLD HARMLESS

GRANTEE shall hold harmless and indemnify GRANTOR, its officers, directors, employees, contractors, agents, and consulting engineers, from and against any and all losses, damages, or liability to the maximum extent permitted by law, including but not limited to claims for mechanic's and materialmen's liens, and fees, costs, expenses, claims, suits, or demands on account of or growing out of injury to or death of any person or persons whomsoever, or damage to property resulting or allegedly resulting from the following:

- A. The privileges granted herein;
- B. Acts and work performed by GRANTEE AND GRANTEE'S officers, directors, employees, agents, contractors, subcontractors, consultants or suppliers, pursuant to this GRANT and/or;
- C. On account of or arising out of and due to the exercise of this GRANT by the GRANTEE. As a prerequisite to any recovery therefor from GRANTEE, GRANTOR shall give written notice to GRANTEE of any such claim or the commencement of any such action, suit or defense thereof, and GRANTEE shall have the right to defend or contest any such claim, action, or

- E.22 -

suit. GRANTOR and its agents reserve the right to retain its own or additional counsel and defend such matters, at the sole cost and expense of GRANTEE.

SECTION 4. GRANTOR'S OPERATION

It is understood and agreed that GRANTOR has statutory and contractual duties and obligations for the safe and efficient operation of the Illinois Tollway System on or near the Easement Premises, including the repair, maintenance, relocation, alteration, expansion, and improvement of the Toll Highways and related facilities on or near the Easement Premises. GRANTOR shall not be responsible to GRANTEE or GRANTEE'S employees, agents, engineers, contractors, sub-contractors, and suppliers, or any other persons or parties, for interference, delays, damages, costs, and the like that may be incurred by them due to GRANTOR'S activities, actions, or inactions in meeting and performing said duties, obligations, and responsibilities. GRANTEE shall indemnify and hold GRANTOR harmless, to the maximum extent permitted by law, from any claims, demands, and judgments, including any costs, fees, and expenses related thereto, of any kind or nature of GRANTEE'S agents, engineers, or contractors arising in connection with GRANTOR'S activities, actions, or inactions in performing its duties, obligations and responsibilities for the safe and efficient operation of the Toll Highway System. In the event, in the reasonable judgment of GRANTEE, after consultation with the Chief Engineer, the safety and protection of the CABLE is jeopardized by GRANTOR'S activities or inaction, GRANTEE shall so notify GRANTOR and GRANTOR shall make reasonable efforts to correct such situation.

SECTION 5. INSURANCE

In addition to insurance required of GRANTEE'S agents or contractors herein, GRANTEE at its own expense, shall at all times provide and keep insurance in the minimum amounts set forth below protecting GRANTOR and GRANTEE against any liability to any person or corporation or damage to property arising out of, or in connection with, GRANTEE'S actions or inactions concerning the CABLE or the Easement Premises:

A. Automobile Liability for vehicles, if any, owned or operated by GRANTEE:

\$500,000 Bodily Injury and Property Damage
5,000 Medical Payments
40,000 Uninsured Motorists

B. Worker's Compensation and Employer's Liability Insurance covering the obligations of the company in accordance with the provisions of the Worker's Compensation Law of the State of Illinois.

- E.23 -

C. Comprehensive General Liability:

\$500,000 Bodily Injury per occurrence
500,000 Bodily Injury aggregate limit
500,000 Property Damage per occurrence
500,000 Property Damage aggregate limit

D. Umbrella Coverage: In addition to the limits of coverage specified above, an Umbrella or Excess Liability policy of not less than \$2,000,000 for any one occurrence and subject to the same aggregate over the Comprehensive Automobile Liability, Employer's Liability, and Comprehensive General Liability coverages is required. Umbrella coverage is subject to approval of the GRANTOR as to form and amount of self-insured retention

E. Policies: At all times during this GRANT, current policies or certificates of insurance acceptable to GRANTOR, requiring thirty (30) days prior notice of termination, shall be furnished by the GRANTEE to GRANTOR.

F. Self Insurance: GRANTEE represents that it is currently authorized by the State of Illinois, and in good standing to provide insurance protection as a self-insured. At the option of the GRANTEE, and upon presentation of satisfactory evidence of such authorization to GRANTOR, the provision of SECTION 5. INSURANCE above, only insofar as the requirement of providing insurance policies to GRANTOR may be waived. In the sole judgment of GRANTOR in the event the financial condition of GRANTEE, or upon withdrawal of such authorization by the State of Illinois, requires additional protection to guarantee the insurance coverage in said SECTION 5 above, GRANTEE will within five (5) days after demand by GRANTOR, provide and submit to GRANTOR all the insurance policies on the amounts set forth in said SECTION 5. above.

SECTION 6. DEFAULT - GRANTOR'S REMEDIES

A. Termination: In the event GRANTEE violates this GRANT or any material provision thereof, GRANTOR shall have a right to terminate this GRANT as to all or any part of the Easement Premises. Prior to exercising said right of termination, GRANTOR shall give GRANTEE thirty (30) days prior written notice, declaring a material breach and demanding that GRANTEE cure such breach within thirty (30) days. If the nature of the violation or breach reasonably requires more than thirty (30) days to correct or cure and GRANTEE immediately begins and diligently prosecutes efforts to cure, then GRANTEE shall be allowed a reasonable time to cure said violation of this GRANT and GRANTOR may not terminate the GRANT therefor until after said reasonable period has expired. If said violation is not

- E.24 -

corrected within said period, GRANTOR, at GRANTOR'S sole option, may forthwith terminate said GRANT as to all or such part of the Easement Premises as GRANTOR, in its sole discretion, may decide, or GRANTOR may proceed to correct said violation at GRANTEE'S sole cost. In the event of termination of the GRANT, or any part thereof, GRANTEE shall, at the option of GRANTOR, be responsible for removing all improvements and equipment placed upon the Easement Premises or the portion thereof as to which this GRANT has been terminated and for the restoration of said premises to its condition at the time of execution of this GRANT; all removal and restoration work to be commenced immediately and prosecuted diligently, and to be completed not later than sixty (60) days from the date of notice of said violation or breach and, according to plans, specifications and procedures approved by GRANTOR, all at GRANTEE'S sole cost and expense.

B. Court Proceedings: In addition to GRANTOR'S right and option of termination, GRANTOR shall alternatively and additionally have the right to institute proceedings in any appropriate court to compel the observance by GRANTEE of any covenants and obligations of this GRANT, and for the collection of sums due or damages incurred by GRANTOR for violation of GRANTEE'S covenants and obligations herein. This clause shall not be intended as a waiver or limitation of GRANTOR'S rights in connection with a violation or breach of this GRANT or the law by GRANTEE, its officers, employees, agents, and contractors, subcontractors, consultants or suppliers, and GRANTOR shall have all other rights or remedies as may be available to it under law or in equity.

SECTION 7. REMOVAL

GRANTEE, at the option of GRANTOR, shall remove all of the CABLE located on or installed on GRANTOR'S property or the Easement Premises, or such parts of the CABLE as GRANTOR shall direct, according to procedures, plans and specifications approved by GRANTOR in the event:

A. GRANTEE fails to complete construction and installation of the CABLE according to approved plans and specifications within the time provided in ARTICLE II, SECTION 3;

B. If GRANTOR terminates this GRANT for GRANTEE'S failure to comply with the terms or any term of this GRANT following receipt of notice thereof;

C. At the termination of the established term of this GRANT or at the termination of the optional extension period or any other extension or renewal hereof.

- E.25 -

Should GRANTOR direct GRANTEE to remove the CABLE or any portion or portions thereof, GRANTEE shall promptly commence and complete said removal work in accord with plans, specifications and procedures approved by GRANTOR, all removal work to be performed without interference to the safe and efficient operation of the Tollway System and shall promptly restore GRANTOR'S property and the Easement Premises to its original condition following the removal of all CABLE and other GRANTEE improvements. In the event GRANTEE fails to remove the CABLE or any part thereof as required by this GRANT, GRANTOR may proceed with its own forces or retain other engineers and contractors to perform such removal and restoration work after first giving GRANTEE a written estimate of the cost thereof, and GRANTEE shall promptly reimburse GRANTOR for any and all costs, fees, and expenses incurred in connection therewith.

SECTION 8. RIGHTS OF GRANTOR'S BONDHOLDERS

It is agreed between the GRANTOR and GRANTEE that, notwithstanding anything herein contained to the contrary, this GRANT shall be subject to the rights of the holders of GRANTOR'S bonds as contained in the terms, covenants, and conditions of the Bond Resolutions of the Authority. GRANTEE hereby waives any and all claims, rights, and damages it has or may hereafter have from time to time during the term hereof, or any extension thereto, which it may incur due to GRANTOR'S compliance with any order of the court entered in an action by or on behalf of a Bondholder.

SECTION 9. WAIVER OF GRANTEE'S RIGHTS

GRANTEE hereby waives any statutory or other immunity it may have to actions at law or in equity for failure of GRANTEE to comply with the terms of this GRANT.

SECTION 10. TOLLS

Nothing in this GRANT authorizes GRANTEE, its engineers, employees, agents, contractors or subcontractors to free use of the Toll Highway System. The payment of tolls and compliance with established rules and regulations of the Toll Highway System will be required.

SECTION 11. SUCCESSORS AND ASSIGNS - ASSIGNMENT

The rights and obligations of GRANTOR and GRANTEE shall inure to the benefit of and be binding upon their respective successors, assigns in office and in title, to GRANTOR'S property, including all terms, conditions, benefits, and burdens. GRANTEE may not assign its rights or interest hereunder without the prior written approval of GRANTOR which approval GRANTOR shall not unreasonably withhold or delay.

- E.26 -

SECTION 12. REVERSION

By the acceptance hereof, GRANTEE agrees to the terms and conditions of this GRANT, and in the event of violations thereof, in addition to the requirements, obligations, damages, and responsibilities of GRANTEE hereunder, the Easement interest, upon the serving of written notice to GRANTEE thereof, shall revert to GRANTOR, its successors and assigns, and GRANTEE shall have no further interest in said property pursuant to this GRANT. In such event, GRANTEE agrees to execute any and all documents reasonably required to effectuate said reversion.

SECTION 13. NOTICES

Notices to be given hereunder or documents to be delivered shall be deemed sufficient if delivered personally or mailed by certified mail to the GRANTEE at 300 South Riverside Plaza, 2nd Floor, Chicago, Illinois 60606, or to the GRANTOR, Attention: Chief Engineer, at 2001 West 22nd Street, Oak Brook, Illinois 60521. Either party may change the place to which notices hereunder may be addressed by prior written notice to the other party at any time or times.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement the day and year first above written.

THE ILLINOIS STATE TOLL HIGHWAY
AUTHORITY

By: [Signature]

Chairman

ATTEST:

[Signature]
Assistant Secretary

AT&T COMMUNICATIONS, INC.

By: [Signature]

G. A. Gipple VICE PRESIDENT NETWORK
(Name typed) (Title)

ATTEST:

[Signature]
Assistant Secretary

APPROVED
AS TO FORM

[Signature]
Clerk

Approved as to Form and Constitutionality

[Signature]
Attorney General, State of Illinois

Appendix F

DOCUMENTATION OF GEORGIA FEE DETERMINATION



Department of Transportation
State of Georgia
Office of Materials and Research
15 Kennedy Drive
Forest Park, Georgia 30050-2599
February 24, 1986

DIV ADMS		
ASST DIV ADMS		
DIST A		
DIST B		
FIN MGR		
P & R ENGR		
BR ENGR		
REALTY OFF		

Mr. Louis M. Papet
Division Administrator
ATTENTION: Grover Bowman
Federal Highway Administration
1720 Peachtree Rd., NW, Suite 300
Atlanta, GA 30367

Dear Mr. Papet:

Subject: Special Research Study No. 8505, "Determining Proper Charges
for Utilities Use of Highway Right-of-Way"

The purpose of this letter report is to provide you with documentation as to what we accomplished on the subject study and to provide notice that we wish to close this study out.

The objective of this project was to determine the cost to GDOT for utilities using the R/W including increased construction costs due to utility conflicts and delays and to determine a proper and equitable annual per mile charge to assess against communications companies using highway R/W for trunk lines.

The objective was accomplished by examining construction cost files for all projects completed in 1983 and 1984 to identify those that involved utility conflicts. We assumed that the bid items of unclassified excavation and pipe items were the only bid items affected by utility conflicts. We also did not include bridge replacement or other projects which did not specify a project length in our analysis even if they had utility conflicts.

Attachment 1 is a listing of the 46 projects in 1983 that had utility conflicts which were used in our analysis. Attachment 2 is an explanation of how we calculated a range of annual per mile costs for utility conflicts based on the data from Attachment 1. The annual cost figures were amortized over the 20 year useful life for a road and included a range of interest rates and percent increases in the cost of unclassified excavation and pipe items.

We later went back and did a similar analysis of increased construction costs due to utility conflicts for calendar year 1984. These cost figures were combined with those for calendar year 1983. Attachment 3 shows how we calculated annual per mile costs for utility conflicts based on combined 1983

Mr. Louis M. Papet

-2-

February 24, 1986

and 1984 construction cost data. The annual per mile cost table for utility conflicts was calculated for interest rates of 10, 12, and 15 percent and increases in unclassified excavation and pipe items of 25, 37.5, and 50 percent. We learned from contractors that they increase the cost of unclassified excavation and pipe items from 25 to 50 percent to cover the increased cost due to utility delays.

The above information was provided to the Office of Utility to use in negotiating with utility companies an annual per mile charge for their using our highway R/W for trunk lines.

If you have any questions about this brief report or our study please contact Lamar Caylor.

Sincerely,



Tom Stapler, P.E.
State Materials & Research Engineer

TS:LNC:cvc

Attachments

PAGE NO. 00001

02/12/84

BID IN COSTS DUE TO UTILITY CONFLICTS FOR CALENDAR YEAR 1983

LET NO.	LETTING DATE	PROJECT NUMBER	COUNTY	CONTRACTOR	ORIGINAL CONTRACT AMOUNT	UNCLASS. EXCAV.	PIPE ITEMS	PROJ. LENGTH X/O'S
21	01/29/83	PR-416-4 (57)	CHEROKEE	PARANOUNY CONTR. CO.	238941	23100	49345	484
4	02/25/83	B001-8530-15 (245) CT 1	RICHMOND	KNOX RIVERS CONST. CO.	590323	14250	90112	1087
26	02/25/83	TSAP-193 (9)	WALKER	TALLEY CONST. CO.	1050061	135000	98080	4051
27	02/25/83	F-42-2 (17)	BALDWIN	CENTRAL GEORGIA CONST. CO.	2055632	133455	165033	4221
45	02/25/83	F-26-1 (48)	CHATTAHOOC	BRADY WILLIAMSON CONTR., INC.	1938136	398496	179155	2414
48	02/25/83	PR-44-4 (61)	CLAY	REEVES CONST. CO.	74592	22500	6204	1000
5	03/11/83	ACT-8-1-185-1 (208) CT 10, ETC.	MUSCOGEE	WRIGHT CONTR. CO.	2393300	914641	213268	1735
9	03/25/83	I-1D-675-1 (137) CT 12	HENRY	APAC GEORGIA, INC.	3541432	805600	78590	1841
18	03/25/83	TSAP-1 (102)	TROUP	REEVES CONST. CO.	1093082	36560	123530	1034
31	03/25/83	H-4013 (1)	CHATHAM	PITTMAN PAVING CO.	1371021	10500	282673	1437
32	03/25/83	N-AD-20-1 (12)	CAMDEN	HENRY L. TROTMAN CO.	879202	11375	107760	1854
17	04/22/83	F-8-1 (34)	APPLING	HOLLAND CONTR. CO.	912217	13500	149076	1853
9	04/29/83	F-7-1 (35) CT 1	GRADY	M. E. ROSS & SONS, INC.	2094910	237540	113510	3925
43	05/27/83	F-168-1 (5) CT 4	FULTON	PLANT IMPROVEMENT CO. INC.	504322	94250	29670	80
60	05/27/83	PR-107-2 (179)	LIBERTY	M. E. ROSS & SONS, INC.	111308	12000	14680	909
15	08/09/83	F-5-5 (3)	BULLDOCH	SOUTHERN AGGREGATES CO.	1311256	36550	169570	2467
18	08/09/83	F-2-2 (20) CT 2 & F-8-1 (37) CT 2	JEFF DAVIS	M. E. ROSS & SONS, INC.	940165	47600	75505	2704
23	08/09/83	FFD-F-7-4 (26) CT 7	GLYNN	M. E. ROSS & SONS, INC.	2247514	62300	160904	4677
24	08/09/83	F-8-1 (38)	GLYNN	PLANT IMPROVEMENT CO. INC.	1990906	11200	183824	2307
25	08/09/83	N-AD-20-1 (8)	CAMDEN	D. E. SMITH, INC.	1645719	30523	92322	2826
2	07/08/83	APD-ACAPD-34-2 (2) CT 15, ETC.	PICKENS	NEWELL ROADBUILDERS, INC.	6202686	3876880	377314	7857
26	07/08/83	PR-100-4 (29)	BRYAN	M. E. ROSS & SONS, INC.	117799	16500	7584	1110
32	07/08/83	FR-51-1 (15) & MEB-51-1 (14)	ELBERT	MOORE'S PAVING CO.	500027	87000	0	11810
38	07/22/83	F-114-2 (31) CT 2 & F-114-2 (41) CT 2	STEPHENS	APAC TENNESSEE, INC.	3641758	1737972	194570	5341
1	08/12/83	I-75-2 (128) CT 16	FULTON	JASPER CONST. CO.	21392391	1952600	610955	937
62	08/15/83	RS-1358 (5) CT 1, ETC.	WALKER	THOMAS BROS. CONST. CO.	3794414	2221250	316555	7739
15	09/09/83	F-74-1 (29)	HERKIMER	HILL CONST. CO.	117297	29381	17737	148
4	09/23/83	TSAPF-10-2 (30)	FULTON	SHEPHERD CONST. CO.	1144052	44700	44128	2133
18	09/23/83	TSAPF-26-1 (46) CT 1	CHATTAHOOC	DANIEL & DANIEL, INC.	1893671	783990	253150	4974
21	09/23/83	TSAP-377 (4)	BUNTER	REEVES CONST. CO.	316242	8000	49380	681
38	09/23/83	TSAPF-6-3 (3)	BUNTER	REEVES CONST. CO.	298976	30800	27530	1799
37	10/28/83	F-2-5 (18)	MORGAN	KNOX RIVERS CONST. CO.	407420	25410	28780	729
45	10/28/83	F-TSAPF-6-2 (38) CT 4	DOUGHERTY	OXFORD CONTR. CO.	2278693	82500	87810	3077
74	10/28/83	F-43-1 (36) & F-43-1 (37)	RICHMOND	KNOX RIVERS CONST. CO.	1839977	49140	323125	1434
77	10/28/83	N-9265 (3)	DEKALB	PITTMAN HIGHWAY CONTR. CO.	1408176	43450	167202	946
79	10/28/83	F-4-1 (38)	MUSCOGEE	MCMATH, TRUBBELL & TURNER	1387374	28178	105990	927
81	10/28/83	TSAPF-74 (32)	FULTON	SHEPHERD CONST. CO. INC.	84197	12100	8608	477
12	11/18/83	RS-1358 (4)	WALKER	TALLEY CONST. CO. INC.	901630	122200	136274	2833
23	11/18/83	PRH-8502-1 (153)	HOUSTON	A & D ASPHALT CO.	421704	16440	132265	565
26	11/18/83	F-26-1 (41) CT 3 & F-26-1 (42) CT 5	STEWART	NEWELL ROADBUILDERS, INC.	5523958	1140432	359620	9945
51	11/18/83	N-9329 (2) CT 1	DOUG/FULT.	CHARLES SULLIVAN CONST. CO.	1535766	254301	52050	1057
1	12/16/83	I-IR-20-1 (44)	DOUG./COBB	IVIE AND ASSOC., INC.	217164	5153	15416	247
16	12/16/83	BRF-55-1 (28) CT 1, ETC.	CLARKE	SHEPHERD CONST. CO.	741651	45745	65110	1510
24	12/16/83	I-75-3 (115) 267 CT 4, ETC.	COBB	APAC GEORGIA, INC.	3222741	25136	85465	1220
28	12/16/83	M-1126 (1) CT 3	WALKER	SIMPSON BRIDGE CO., INC.	2926347	569970	54893	1561
42	12/16/83	N-9225 (1) CT 1	CHEROKEE	PITTMAN HIGHWAY CONTR. CO.	1291578	44640	15649	983

** TOTAL **

90796928 16304212 6061180 1966

ATTACHMENT 2

ESTIMATED ANNUAL COST FOR UTILITY CONFLICTS
USING 1983 CONSTRUCTION COST DATA

There were 46 projects in 1983 that had utility conflicts. It was assumed that the bid items of unclassified excavation and pipe items were affected by utility conflicts. While it is true that clearing and grubbing is affected by utility conflicts, clearing and grubbing is less affected by utility conflicts than the above two construction items and is harder to determine how much it is affected by utility conflicts. Clearing and grubbing is not included in this analysis.

The annual cost figures in this report do not include projects such as bridge replacement projects (which are very much affected by utility conflicts) or other projects where no mileage is specified, therefore, these estimated cost figures due to utilities are understated.

The ANNUAL COST figure of \$6,232/mi. which uses 10% interest and assumes a 37.5% (average of 25% and 50%) increase in unclassified excavation and pipe items seems to be a reasonable estimate for the cost for utility conflicts. See table below for full range of ANNUAL COST figures for various assumptions of interest rates and 25% to 50% increase in unclassified excavation and pipe costs. These ANNUAL COST figures amortize utility delay costs per mile over the 20 year useful life for a road.

ANNUAL PER MILE COSTS FOR UTILITY CONFLICTS

Annual Interest Rate	10%	12%	15%
25% increase in unclas. excavation & pipe items	\$4,570	\$5,209	\$6,216
37.5% increase in unclas. excav. & pipe items	\$6,232	\$7,103	\$8,476
50% increase in unclas. excav. & pipe items	\$7,617	\$8,682	\$10,360

ATTACHMENT 3

ESTIMATED ANNUAL COST FOR UTILITY CONFLICTS
USING BOTH 1983 AND 1984 CONSTRUCTION COST DATA

There were a total of 94 projects in calendar year 1983 and calendar year 1984 that had utility conflicts and a listed project length. It was assumed that the bid items of unclassified excavation and pipe items were affected by utility conflicts. While it is true that clearing and grubbing is affected by utility conflicts, clearing and grubbing is less affected by utility conflicts than the above two construction items and is harder to determine how much it is affected by utility conflicts. Clearing and grubbing is not included in this analysis.

The annual cost figures in this report do not include projects such as bridge replacement projects (which are very much affected by utility conflicts) or other projects where no mileage is specified, therefore, these estimated cost figures due to utilities are understated.

The ANNUAL COST figure of \$5,790/mi. which uses 10% interest and assumes a 37.5% (average of 25% and 50%) increase in unclassified excavation and pipe items seems to be a reasonable estimate for the cost for utility conflicts. See table below for full range of ANNUAL COST figures for various assumptions of interest rates and 25% to 50% increase in unclassified excavation and pipe costs. These ANNUAL COST figures amortize utility delay costs per mile over the 20 year useful life for a road.

ANNUAL PER MILE COSTS FOR UTILITY CONFLICTS

Annual Interest Rate	10%	12%	15%
25% increase in unclas. excavation & pipe items	\$4,246	\$4,840	\$5,776
37.5% increase in unclas. excav. & pipe items	\$5,790	\$6,600	\$7,876
50% increase in unclas. excav. & pipe items	\$7,077	\$8,067	\$9,626

Appendix G

SUPPORTING COST DATA

The cost data presented in this appendix is based on the experience of companies that have actually installed fiber-optics cables. The eight carriers listed in Table G.1 were contacted as potential contributors; six of the eight provided data.¹ Additionally, engineering firms and cable manufacturers were contacted as necessary.

Our survey solicited data for five basic cost categories: engineering, ROW acquisition, cable procurement, cable installation (placement, splicing, etc.), and regenerator procurement and installation (both structure and electronics). ROW types considered in addition to Interstate freeways were railroads, private land, and non-Interstate highways. Our figure of merit for making cost comparisons among the alternative ROW types was "average installed cost per mile" in a rural, long-haul environment. It should be noted that the term "average" refers to an average over all types of rural terrain and *not* an average of the carrier responses. As the reader will quickly observe, the range of the responses for a couple of cost categories is quite wide—sometimes varying by a factor of more than ten. Given this variance and the fairly small sample size, selection of a nominal value for those categories for use in the analysis was obviously a highly subjective process. For those cost elements relatively *independent* of ROW type, we tried to select either (a) a value supported by additional detail or (b) a modal-type value. For those cost elements *dependent* on ROW type,

Table G.1

CARRIERS CONTACTED FOR COST DATA

AT&T Communications
MCI
U.S. Sprint
CONTEL
LiTel
BellSouth
Pacific Northwest Bell
New York Telephone

¹Proprietary considerations prevent us from identifying the specific companies.

we generally selected the value provided by the carrier with the most experience with that type of ROW.

ENGINEERING

Responding firms indicated that engineering costs for an underground cable are not so much a function of ROW type as they are of the following factors:

- whether or not the firm already has prior experience on the ROW route (from previous cable placement);
- the extent of government rules and procedures;
- the frequency of “obstacles” such as crossroads, other utilities, and business and residence access points;
- whether the cable must be placed in a conduit or whether it can simply be plowed into the ground; and,
- soil conditions (presence of shale/rock).

The following values represent engineering costs for a plowed-in cable on new, rural ROW:

Range of responses: \$1,100 to \$15,000 per mile

Nominal value selected for analysis: \$3,000 per mile

ROW ACQUISITION

The values below are intended to reflect ROW acquisition costs for new,² rural ROW. A discussion of the factors influencing ROW values is provided in Sec. VII.

Railroads

The following values are based on the experience of firms using railroad ROW.

Range of responses: \$8,000 to \$16,000 per mile

Nominal value selected for analysis: \$12,000 per mile

²ROW to which firm does not already have access.

Non-Interstate Highways

As a result of our state highway law survey (see Sec. IV), we were able to determine that most states charge either no fee or a minimal administrative fee. Of the 21 states surveyed, only Georgia charges a significant fee for use of state highway ROW:

Urban area: \$5000 per mile per year
 Rural area: \$2000 per mile per year (> 2000 cars per day)
 \$1000 per mile per year (< 2000 cars per day)

Converted to an equivalent one-time charge,³ the values are:

Urban area: \$31,250 per mile per year
 Rural area: \$12,500 per mile per year (> 2000 cars per day)
 \$ 6250 per mile per year (< 2000 cars per day)

The objective of the Georgia fees is to capture additional state costs associated with future highway maintenance and improvement.

Private Land

One-time payments for easements on rural private land typically run from 50 to 70 percent of the land value. The average state-wide values shown in Table G.2 are based on the higher percentage factor and an assumed 20-ft construction corridor (2.4 acres per linear mile).⁴ What stands out here is the variation—the estimated rural ROW cost in the highest state (New Jersey) is over twenty times greater than that in the lowest state (New Mexico). Even adjoining states can vary widely—the estimated rural ROW cost in New Jersey is over four times that of New York.

CABLE PROCUREMENT

Procurement costs for alternative configurations of 24-fiber cable are provided in Table G.3. All fiber is single mode.

³Present value of 20-year annuity at 15 percent (present value factor = 6.25).

⁴The methodology and source of rural land values were suggested by William Farris of Arthur D. Little, Inc.

Table G.2
ESTIMATED ROW COSTS FOR RURAL PRIVATE LAND
(One-time charge)

State	Average Value of Land per Acre (\$) ^a	ROW Cost per Linear Mile (\$) ^b	State	Average Value of Land per Acre (\$) ^a	ROW Cost per Linear Mile (\$) ^b	State	Average Value of Land per Acre (\$) ^a	ROW Cost per Linear Mile (\$) ^b
Mountain			South Atlantic			Middle Atlantic		
Arizona	230	390	Delaware	1430	2400	New Jersey	3070	5160
Colorado	380	640	Florida	1330	2230	New York	700	1180
Idaho	650	1090	Georgia	750	1260	Pennsylvania	1310	2200
Montana	190	320	Maryland	1820	3060			
Nevada	200	340	North Carolina	1080	1810	New England		
New Mexico	140	240	South Carolina	780	1310	Connecticut	2790	4690
Utah	450	760	Virginia	950	1600	Maine	740	1240
Wyoming	150	250	West Virginia	480	810	Massachusetts	2060	3461
						New Hampshire	1230	2070
East North Central			West South Central			Rhode Island	2900	4870
Illinois	1140	1920	Arkansas	740	1240	Vermont	880	1480
Indiana	1100	1850	Louisiana	1090	1830			
Michigan	920	1550	Oklahoma	490	820	West North Central		
Ohio	980	1650	Texas	570	960	Iowa	930	1560
Wisconsin	740	1240				Kansas	410	690
			East South Central			Minnesota	720	1210
Pacific			Alabama	670	1130	Missouri	570	960
California	1500	2520	Kentucky	790	1330	Nebraska	390	660
Oregon	500	840	Mississippi	730	1230	North Dakota	310	520
Washington	800	1340	Tennessee	850	1430	South Dakota	220	370
						Overall U.S.	590	990

^aStatistical Abstract of the United States, 1986, Department of Commerce, Table No. 1135, Farm Real Estate—Value of Land and Buildings, by State: 1980 to 1985. We have assumed that land values account for 87 percent of total land and building value (which is the overall U.S. average derived from data in Table No. 1134).

^bAverage value of land per acre (\$) × 70 percent × 2.4 acres per mile.

Table G.3
CABLE PROCUREMENT COSTS

	Cable Identification			
	A	B	C	D
Central strength member	Metallic	Nonmetallic	Nonmetallic	Nonmetallic
Sheathing	Metallic	Metallic	Metallic	Metallic
Phosphorous content	Low	Low	Low	Low
Cost per foot (\$)	3.15	3.65	4.35	5.35
Cost per mile (\$)	16,600	19,300	23,300	28,200
Incremental cost per mile (\$)	—	2,700	6,400	11,600

SOURCE: Rough order-of-magnitude (ROM) costs provided by a representative of AT&T Network Systems.

CABLE INSTALLATION

Today, almost all cable installed in rural locations is plowed into the ground. Such an operation usually involves the digging of cable splice pits, a preliminary ripping pass, and the plowing of the cable into the ground (Fig. G.1 illustrates a machine used to do this).⁵ The

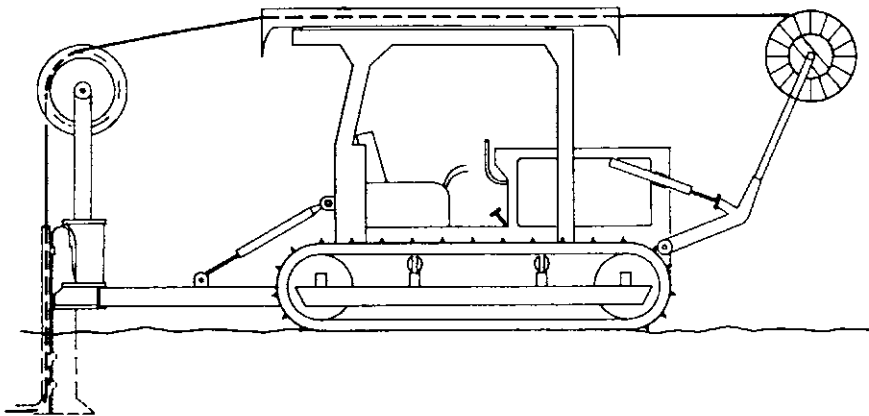


Fig. G.1—Typical cable installation vehicle

⁵The primary alternative to plowing in is to place the cable in conduit. Conduit installation, while offering certain advantages (greater protection for cable, expansion

required separation in the earth is usually only a couple of inches. Costs associated with this concept include all construction labor (fully burdened) and equipment charges for preparation, plowing-in, splicing, testing and inspection, and restoration. Underground cable installation costs will be affected by a number of factors including:

- Type of ROW:
 - Number of obstacles (other utilities, crossroads, business and residence access points)
 - Conditions of access (working hours, safety provisions, and restoration requirements)
- Soil conditions and levelness of terrain
- Location in ROW:
 - Railroads (on-track or off-track)
 - Interstate (fence line, shoulder, median)

Unless otherwise specified, the following values represent plowed-in cable buried at a depth of 36 inches in sandy/clay-type soil. Responses for the railroad, private land, and non-Interstate highway ROWs are based on actual experience. In contrast, the Interstate responses are largely estimates supplemented by experience on somewhat analogous toll roads.

Railroad

Range of responses: \$3200 to \$16,000 per mile (on-track)

Nominal value selected for analysis: \$10,000 per mile (on-track)

Private Land

Range of responses: \$2100 to \$30,000 per mile

Nominal value selected for analysis: \$22,500 per mile

Non-Interstate Highway

Range of responses: \$2400 to \$30,000 per mile

Nominal value selected for analysis: \$27,500 per mile

capability), is relatively expensive initially since it normally involves trenching operations.

Interstate Freeway

The general consensus appears to be that cable installation in the median of an Interstate freeway would be fairly comparable to on-track railroad installation. Moreover, the consensus also appears to be that installation along the fence line of an Interstate freeway would be about 60 percent more expensive than in the median. Thus, the nominal values used in the analysis are:

Median: \$10,000 per mile

Fence line: \$16,000 per mile

The value for the median installation assumes that the cable owners will attach the cable to bridges whenever the Interstate passes over a crossroad or interchange (see top diagram in Fig. G.2). At the fence line, however, the cable is assumed to be buried to the right of all Interstate structures including on/off ramps and under crossroads (see "fence line" diagram in Fig. G.2).

Incremental Cost of Increased Burial Depth (48 in.). The following values are based on LiTel's experience in the median of the Ohio Turnpike and the Indiana Toll Road. Their costs for plowing the cable into the ground (nothing else) were as follows:

36 inches: \$0.70 per foot

48 inches: \$0.90 per foot

Thus, the incremental costs associated with burying the cable in the median at 48 in. rather than 36 in. is roughly \$1000 per mile ($\$0.20 \text{ per foot} \times 5280 \text{ feet}$).

With respect to the 48-in. burial depth at the fence line, we assume the same 60 percent median-fence line differential as was used for the 36-in. burial depth. Thus, the incremental costs associated with burying the cable at the fence line at 48 in. rather than 36 in. is roughly \$1700 per mile ($\$0.20 \text{ per foot in median} \times 1.60 \text{ median-fence line factor} \times 5280 \text{ feet}$).

Incremental Cost of Burial Instead of Bridge Attachment. As stated previously, the baseline value for median installation assumed that the cable would be attached to bridges whenever the Interstate passes over a crossroad or interchange. Alternatively, the cable could be buried down the slope and under the crossroad (see "burial" diagram in Fig. G.2). The incremental cost of doing this, as shown in Table G.4, is roughly \$2500 per mile.

Summary of Interstate Cable Installation Costs. Estimated Interstate cable installation costs are summarized in Table G.5.

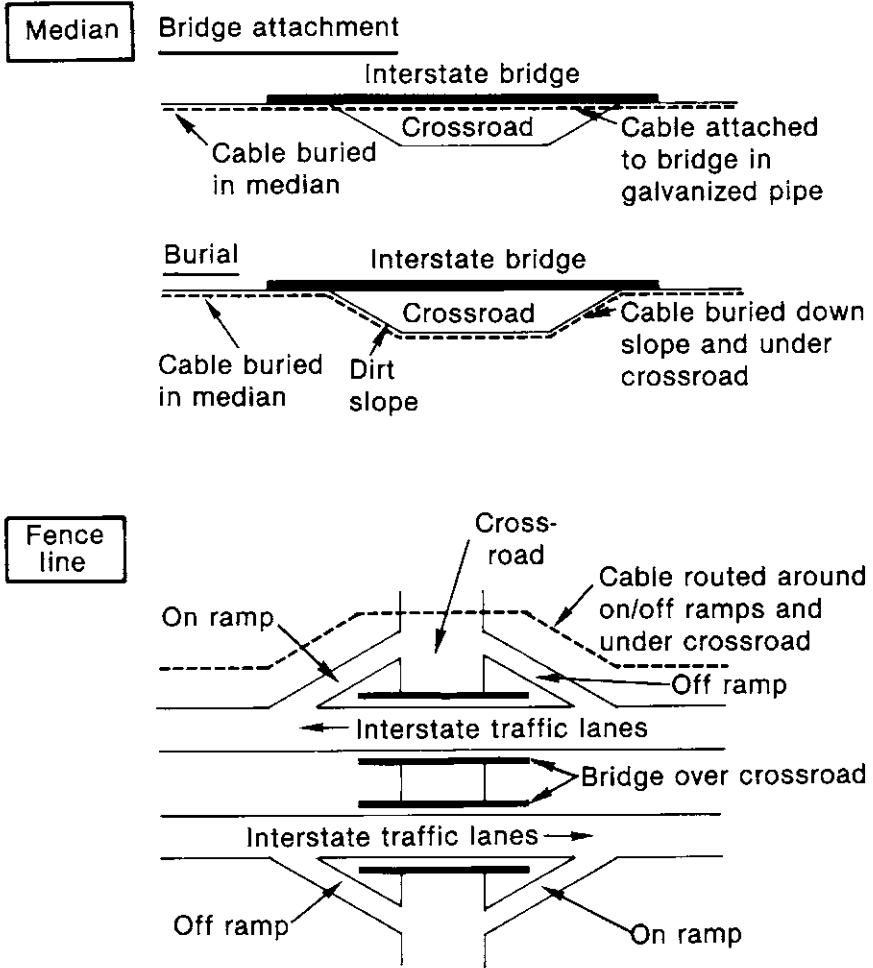


Fig. G.2—Crossings of interchanges and grade separations

REGENERATORS

Installed Structure

Unreinforced surface enclosure:	\$25,000
Reinforced surface enclosure (2 psi overpressure):	\$40,000
Underground enclosure:	\$90,000

Figure G.3 shows an unreinforced surface enclosure and Fig. G.4 illustrates an underground enclosure.

Electronics

Regenerator electronics in the 400–500 Mbps range are estimated as:
\$80,000 + \$22,000 per fiber pair

We assume that all regenerators will get a full complement of electronics. Thus, for a 24-fiber cable, the electronics package will cost \$344,000.



Fig. G.3—Surface enclosure

Table G.4

**MEDIAN INSTALLATION: COST OF CROSSING
INTERCHANGES AND GRADE SEPARATIONS**

	Bridge	
	Attachment	Burial
Crossing length (ft) ^a	150	150
× cost per foot (\$) ^b	× 50	× 100
Cost per crossing (\$)	7500	15,000
Crossing spacing (miles) ^c	÷ 3	÷ 3
Overall cost per mile (\$)	2500	5000
Incremental cost per mile (\$)	—	2500

^aLength of span over crossroad was determined as follows:

12 ft per traffic lane × 4 traffic lanes

= 48 ft

30 ft for shoulders (15 ft per side)

60 ft for slopes (30 ft per side)

138 ft (assume nominal 150 feet)

^bBROM costs provided by Telecommunications Services, Inc.

^cBased on discussions with FHWA personnel. Rural Interstates typically have an interchange every 8 miles and a through crossroad about every 1-1/2 miles. For simplicity, we assume an interchange or through crossroad every 1-1/2 miles. Additionally, we assume that the Interstates go through on level ground about half the time (crossing above the other half). Thus, the effective spacing for interchange/grade separation bridges is roughly every 3 miles.

Table G.5

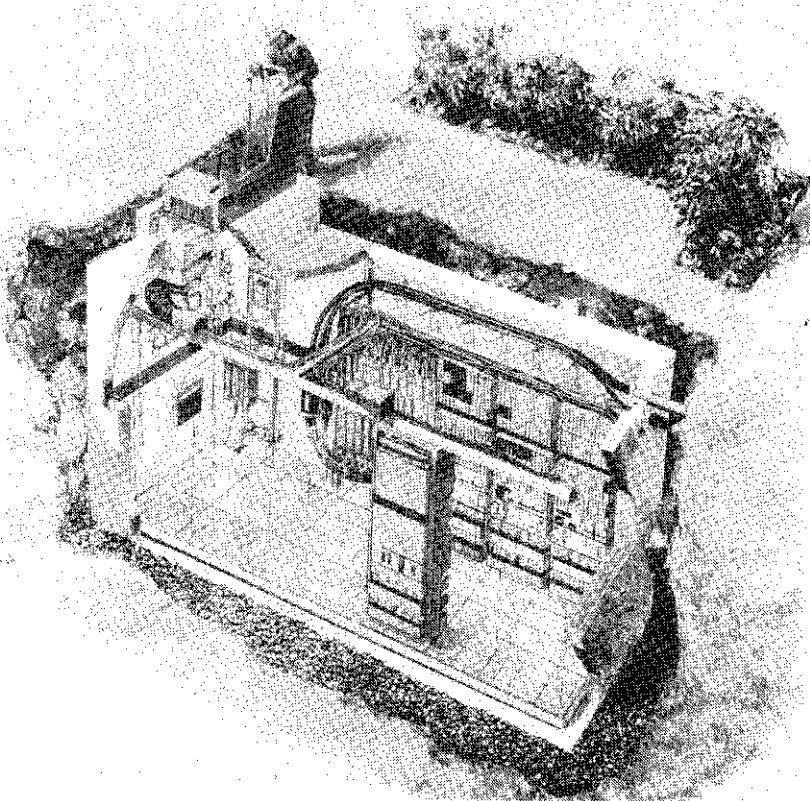
**INTERSTATE CABLE INSTALLATION COSTS
(\$ per mile)**

	Cable Burial Depth	
Location in ROW	36 inches	48 inches
Median		
Bridge attachment ^a	10,000	11,000
Burial ^a	12,500	13,500
Fence line	16,000	17,700

^aMethod of crossing interchanges and crossroads.

Backup Power

8-16 hour battery:	\$10,000
Diesel generator with automatic kick-in, fuel for 14 days, in surface enclosure	\$30,000
Diesel generator with automatic kick-in, fuel for 14 days, in underground enclosure	\$60,000



SOURCE: Bellcore

Fig. G.4—Underground enclosure

Summary of Regenerator Costs

Based on a regenerator spacing of 25 miles, the per-mile costs for the three regenerator configurations examined in our analysis are shown in Table G.6.

CROSSINGS OF NATURAL WATERWAYS

Crossings of natural waterways were not included in our generalized per-mile cost estimates because of their irregular spacing and characteristics. However, we were able to obtain some rough approximations of the costs of alternative means for crossing bodies of water from Telecommunications Services, Inc.:

Attachment to bridge (in galvanized pipe): \$45 to \$50 per foot

“Jetting-in” to river or lake bed

River: \$50 to \$150 per foot depending on current speed
and distance, average of ~ \$100 per foot

Lake: Average of \$75 to \$80 per foot

Boring under waterway: \$70 to \$250 per foot

Our tentative conclusion is that jetting the cable into a river or lake bed (to a depth of about 30 inches) is about twice as costly as bridge attachment.

Table G.6

COSTS OF ALTERNATIVE REGENERATOR CONFIGURATIONS

Description			
Type of enclosure	Surface, unreinforced	Surface, reinforced	Underground vault
Type of backup power	Battery, surface	14-day diesel, surface	14-day diesel, underground
Costs			
Installed structure	\$25,000	\$40,000	\$90,000
Electronics			
Common	80,000	80,000	80,000
Variable	264,000	264,000	264,000
Backup power	10,000	30,000	60,000
Total	379,000	414,000	494,000
Cost per mile	15,160	16,560	19,760

